

**U.S. DEPARTMENT OF THE INTERIOR**

**ENVIRONMENTAL ASSESSMENT**

**PRIME HOOK NATIONAL WILDLIFE REFUGE  
WILDLAND FIRE MANAGEMENT PROGRAM**

U.S. Fish and Wildlife Service  
Prime Hook National Wildlife Refuge  
11978 Turtle Pond Road  
Milton, DE 19968

January 2009

# **PUBLIC COMMENT REQUESTED**

## ***Prime Hook National Wildlife Refuge***

### **WILDLAND FIRE MANAGEMENT PROGRAM**



An Environmental Assessment (EA) for the Wildland Fire Management Program on the Prime Hook National Wildlife Refuge (NWR) is available for your review and comment at the following locations:

Refuge Office  
Milton Library

<http://www.fws.gov/northeast/primehook/fire.html>

It is a policy of the Department of Interior (620 DM 1) that all areas with burnable vegetation have a fire management plans (FMP). Prime Hook NWR currently manages wildland fire under the guidance of a FMP approved in 2002. At that time, the staff of Prime Hook NWR developed an EA to analyze alternative strategies for the wildland fire management program. However, the U.S. Fish and Wildlife Service policy requires that FMPs be reviewed annually and updated every five years as needed to incorporate changes in operations or policy that may have occurred in the intervening years.

The EA has been updated and explores methods in which the Service can carry out policies consistent with refuge management objectives and analyzes the foreseeable impacts that can reasonably be attributed to the alternative methods. The National Environmental Policy Act requires public participation. The Service is currently seeking public comments on the environmental assessment of Prime Hook NWR's fire management program.

Mailed comments may be submitted to:

Refuge Manager  
Prime Hook NWR  
11978 Turtle Pond Rd.  
Milton, DE 19968

Electronic input/comments may be submitted to: [fw5rw\\_phnwr@fws.gov](mailto:fw5rw_phnwr@fws.gov)

**Deadline for Comment Period: February 10, 2009**

For further information, please contact: Michael Stroeh, Refuge Manager, 302-684-8419

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## **I. Purpose and Need for Action**

### **A. Introduction**

The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." (National Wildlife Refuge Improvement Act, 1997)

It is a policy of the Department of the Interior (620 DM 1) that all areas with burnable vegetation have a fire management plan (FMP). Prime Hook National Wildlife Refuge (NWR) currently manages wildland fire under the guidance of a Fire Management Plan (FMP) approved in 2002. At that time, the staff of Prime Hook NWR developed an Environmental Assessment (EA) to analyze alternative strategies for the wildland fire management program. However, US Fish and Wildlife Service (Service) policy requires that FMPs be reviewed annually and updated every five years as needed to incorporate changes in operations or policy that may have occurred in the intervening years

This EA and associated FMP are being prepared in anticipation of development and approval of a refuge Comprehensive Conservation Plan in the near future. In the meantime, there is a continuing need to manage wildland fire and provide for the protection of life, property, and resources, while perpetuating natural processes. Changes in interagency fire management policy, fire management practices, and refuge acreage and habitat objectives are being incorporated into a 2009 FMP revision.

This Environmental Assessment explores methods in which the Service can carry out policies consistent with refuge management objectives and analyzes the foreseeable impacts that can reasonably be attributed to the alternative methods.

### **B. Need for Current Process**

Since 2000, the issue of wildfires spreading off federal lands into Wildland Urban Interface (WUI) communities has gained prominent political attention. The National Fire Plan (NFP) was established in a collaborative effort between the Department of the Interior, the U. S. Forest Service, the Western Governors' Association, and various stakeholder groups as a ten year response to the nation-wide hazardous fuel and WUI problem that became evident in the 2000 fire season. The NFP strategy recognizes that key decisions in setting priorities for restoration, fire, and fuel management should be made at local levels. The NFP resulted in budget allocations targeted to treat hazardous fuels in WUI areas. A cohesive fuels management strategy was adopted by the Department of the Interior and the USDA Forest Service in 2006.

As a result of this focus nationally, the need for hazard fuels treatments in WUI areas near refuge boundaries became more obvious to refuge staff. In July 2001, the Refuge submitted a multi-year, \$1.2 million proposal to reduce fuels to help protect the 667 homes that lie adjacent to the refuge in the three beach communities. While it had been recognized since at least the mid-1980s that a firebreak was needed to help protect these relatively isolated communities from the threat of a wildfire, action had been limited by lack of funds. In the meantime, fuels buildup accelerated after a storm surge event in 1998, greatly expanding an infestation of a non-native variant of the common reed *Phragmites australis*.

Following a site visit and verification by Delaware State Forestry officials, the communities of Broadkill Beach and Prime Hook Beach were identified as among the Highest Risk Communities in the vicinity of Federal Lands nationally, as published in the *Federal Register* in early 2002.

Following approval of funding for the proposed project, hazard fuels treatments near the communities of Slaughter Beach, Prime Hook Beach, and Broadkill Beach began in 2002 and continued through 2004. Implementation partners included Milton and Slaughter Beach Volunteer Fire Departments, Delaware Forest Service, the U.S. Geological Survey, Maryland-Delaware District Water Resources Division, NASA Wallops Island station, Prime Hook volunteers, and private property owners. Aerial imagery and LiDAR technology were used to help identify treatment areas of dense *Phragmites* stands west of the WUI communities. Management goals were developed for two types of treatment areas.

- For ZERO TOLERANCE ZONES, remove 100% of *Phragmites* fuels (live and dead) within a 1,000 foot buffer zone west of each of the 3 beach communities adjacent to the refuge and along respective access roads.
- For LIMITED TOLERANCE ZONES, reduce and/or eliminate *Phragmites* cover, height, density and litter depths (fuel loads) within the sampled population.

The method of assessment for Zero Tolerance Zones is visual inspection and photos; for Limited Tolerance Zones, it is transect data. A monitoring plan was developed for the WUI Project to help determine the need for additional treatments in the future. If Alternative B is selected, the fire management program will implement the monitoring plan and maintain the Zero Tolerance and Limited Tolerance Zones of the WUI project.

The human-caused Slaughter Beach wildfire of March 10, 2002 demonstrated the threat a wildfire in the nearby marsh during a typical late winter cold front passage can pose to the beach communities. The fire burned 1,250 acres west and south of Slaughter Beach, from about 1:30 PM into the evening. A backfire was set to contain the fire along Fowler Beach Road and a tractor-plow built fireline was constructed to contain its western flank. Scores of fire apparatus were deployed to protect homes and attack the fire. During the fire, the observed relative humidity was at or under 30% and wind speed at or over 20 mph (source: archived data of the refuge automated weather station). Flame lengths of 20 feet and forward spread rates over 110 feet per minute, which preclude direct attack, even if access permitted. Images of this wildfire and its extent are in Appendix B.

Effective glyphosate application requires at least two consecutive years of treatment. During the WUI Project nearly 11,000 acres were treated, but the treatment footprint was approximately 4,000 acres. Aerial spraying by fixed wing aircraft applied herbicide began the project; some of the area was re-sprayed by helicopter in 2003. In March 2003, prescribed fire burned 2,135 acres previously sprayed to remove dead canes. Ground treatments in 2004 targeted areas with re-sprouts. A table below summarizes treatments.

Table 1. Prime Hook WUI Project Treatment Summary

Calendar Year	Acres Treated	FWS Acres	Private Acres	Private Landowners	Ground Treatments
2002	3,900	3,100	800	153	100 acres
2003	4,075	3,150	925	177	75 acres
2004	2,950	2,450	500	177	500 acres

Maps of the WUI project area and the annual treatments are in Appendices C and D. There is a need for a long-term program of hazardous fuel treatments to help protect communities adjacent to the refuge. This was not considered in the 2002 Environmental Assessment or Fire Management Plan and is not included in the current program. A new option, Alternative B, adds the features of the WUI project as an on-going program to the current wildland fire management program. Without this enhancement, prescribed fire would be the primary tool available to reduce hazardous fuels. Herbicide treatments to continue to eliminate infestations of *Phragmites* in conjunction with other treatments *could not be made*. In WUI areas, prescribed fire presents an increased risk to managers due to fuel flammability, limited access, limited times when treatments can be scheduled and be effective, and smoke management issues.

Also impacting the current process are changes in interagency wildland fire policy (Department of Agriculture, Forest Service and Department of the Interior). Wildfires must receive an appropriate management response (AMR). This policy direction provides for a more considered approach to managing wildfires, stressing the need for Incident Commanders and agency administrators to evaluate various strategies and tactics for each incident rather than engaging immediately and always in "full suppression" without consideration for firefighter and public safety, values to protect, and costs and impacts of actions. Suppression is an appropriate response for fires that threaten values that need protection, and when it can be done safely and effectively. On the other hand, typical management of a wildfire in a wetland might include allowing a portion of the fire to "burn itself out" in the marsh, where flame lengths and rate of spread can present unnecessary risks to firefighters, where constructing fireline can cause significant resource damage, and where firelines may not be needed to contain and control the wildfire. AMR for a large marsh fire might, for example, use different combinations of strategies and tactics on different flanks of the fire, depending on access, fire behavior, values to protect, availability of suppression resources, costs, and other factors. Stated another way, AMR considers potential outcomes in selecting strategies and tactics which may range from aggressive suppression and mop-up to allowing less aggressive but equally effective strategies and tactics, tailored to the situation.

AMR as applied at Prime Hook NWR in the proposed 2009 FMP typically will result in suppression of all wildfires at the smallest size practicable. AMR as applied at Prime Hook NWR under this plan does not provide for wildland fire use.

### **C. Decision to be made and Responsible Official**

This Environmental Assessment is written to inform the public of a pending decision regarding the 2009 Prime Hook NWR Wildland Fire Management Plan, which will guide wildland fire activities for the next five years. Decision alternatives are Alternative A, continue the current Wildland Fire Program as approved in 2002, or Alternative B, continue the approved program with added effective treatment of refuge hazard fuels and habitats in WUI areas near three adjacent beach communities and other portions of the refuge, as described herein as primary and secondary treatment zones.

The responsible official for a decision is:

Project Leader  
Prime Hook National Wildlife Refuge  
11978 Turkle Pond Road  
Milton, Delaware 19968

## II. Selection of Decision Alternatives

### A. Definitions of Terms

The following definitions are used throughout this document. The source of the definitions is the glossary of the National Wildfire Coordinating Group, which represents federal, state, and local firefighting agencies and departments nation-wide. To view these and other definitions related to wildland fire, visit the web site at <http://www.nwcg.gov/pms/pubs/glossary/w.htm>

**Agency Administrator** - Managing officer of an agency, division thereof, or jurisdiction having statutory responsibility for incident mitigation and management. Examples: NPS Park Superintendent, BIA Agency Superintendent, USFS Forest Supervisor, BLM District Manager, FWS Refuge Manager, State Forest Officer, Fire Chief, Police Chief.

**Appropriate Management Response (AMR)** - Any specific action suitable to meet Fire Management Unit (FMU) objectives. Typically, the AMR ranges across a spectrum of tactical options (from monitoring to intensive management actions). The AMR is developed by using Fire Management Unit strategies and objectives identified in the Fire Management Plan.

**Arson** - At common law, the malicious and willful burning of another's dwelling, outhouse or parcel; by most modern statutes, the intentional and wrongful burning of someone else's, or one's own, property. Frequently requires proof of malicious or wrongful intent.

**Backfire** - A fire set along the inner edge of a fireline to consume the fuel in the path of a wildfire or change the direction of force of the fire's convection column.

**Burn Severity** - A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts.

**Cold Front** - The leading edge of a relatively cold air mass which displaces warmer air, causing it to rise. If the lifted air contains enough moisture, cloudiness, precipitation and even thunderstorms may result. As fronts move through a region, in the Northern Hemisphere, the winds at a given location will experience a marked shift in direction. Ahead of an approaching cold front, winds will usually shift gradually from southeast to south, and on to southwest. As a cold front passes, winds shift rapidly to west, then northwest. Typical cold front wind speeds range between 15 and 30 mph but can be much higher

**Contained** - The status of a wildfire suppression action signifying that a control line has been completed around the fire, and any associated spot fires, which can reasonably be expected to stop the fire's spread.



**Controlled** - The completion of control line around a fire, any spot fires therefrom, and any interior islands to be saved; burned out any unburned area adjacent to the fire side of the control lines; and cool down all hot spots that are immediate threats to the control line, until the lines can reasonably be expected to hold under the foreseeable conditions.

**Control Line** - An inclusive term for all constructed or natural barriers and treated fire edges used to control a fire.

**Emergency Stabilization** - Planned actions to stabilize and prevent unacceptable degradation to natural and cultural resource, to minimize threats to life or property resulting from the effects of a fire, or to repair/replace/construct physical improvements necessary to prevent degradation of land or resources.

**Extended Attack** - Suppression activity for a wildfire that has not been contained or controlled by initial attack or contingency forces and for which more firefighting resources are arriving, en route, or being ordered by the initial attack incident commander.

**Fire Management** - Activities required for the protection of burnable wildland values from fire and the use of prescribed fire to meet land management objectives.

**Fire Management Plan (FMP)** - A plan which identifies and integrates all wildland fire management and related activities within the context of approved land/resource management plans. It defines a program to manage wildland fires (wildfire, prescribed fire, and wildland fire use). The plan is supplemented by operational plans, including but not limited to preparedness plans, preplanned dispatch plans, and prevention plans. Fire Management Plans assure that wildland fire management goals and components are coordinated.

**Fire Management Unit (FMU)** - A land management area definable by objectives, management constraints, topographic features, access, values to be protected, political boundaries, fuel types, major fire regime groups, etc. that set it apart from the characteristics of an adjacent FMU. The FMU may have dominant management objectives and pre-selected strategies assigned to accomplish these objectives.

**Flame Length** - The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity.

**Flaming Combustion Phase** - Luminous oxidation of gases evolved from the rapid decomposition of fuel. This phase follows the pre-ignition phase and precedes the smoldering combustion phase, which has a much slower combustion rate. Water vapor, soot, and tar comprise the visible smoke. Relatively efficient combustion produces minimal soot and tar, resulting in white smoke; high moisture content also produces white smoke.

**Flaming Front** - That zone of a moving fire where the combustion is primarily flaming. Behind this flaming zone combustion is primarily glowing or involves the burning out of larger fuels (greater than about 3 inches in diameter). Light fuels typically have a shallow flaming front, whereas heavy fuels have a deeper front.

**Flaming Phase** - That phase of a fire where the fuel is ignited and consumed by flaming combustion.

**Forward Rate of Spread** - The speed with which a fire moves in a horizontal direction across the landscape, usually expressed in chains per hour or feet per minute.

**Fuel** - Any combustible material, especially petroleum-based products and wildland fuels.

**Fuel Characteristics** - Factors that make up fuels such as compactness, loading, horizontal continuity, vertical arrangement, chemical content, size and shape, and moisture content.

**Fuel Continuity** - The degree or extent of continuous or uninterrupted distribution of fuel particles in a fuel bed thus affecting a fire's ability to sustain combustion and spread. This applies to aerial fuels as well as surface fuels.

**Fuel Loading** - The amount of fuel present expressed quantitatively in terms of weight of fuel per unit area. This may be available fuel (consumable fuel) or total fuel and is usually dry weight.

**Fuel Management** - Act or practice of controlling flammability and reducing resistance to control of wildland fuels through mechanical, chemical, biological, or manual means, or by fire, in support of land management objectives.

**Fuel Model** - Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

**Hazard Fuel** - A fuel complex defined by kind, arrangement, volume, condition, and location that presents a threat of ignition and resistance to control.

**Hazard Reduction** - Any treatment of living and dead fuels that reduces the potential spread or consequences of fire.

**Incident Command System (ICS)** - A standardized on-scene emergency management concept specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.

**Incident Commander (ICT1, ICT2, ICT3, ICT4, or ICT5)** - This ICS position is responsible for overall management of the incident and reports to the Agency

Administrator for the agency having incident jurisdiction. This position may have one or more deputies assigned from the same agency or from an assisting agency(s).

**Initial Action** - The actions taken by the first resources to arrive at a wildfire or wildland fire use incident. Initial actions may be size up, patrolling, monitoring, holding action or aggressive initial attack.

**Initial Attack (IA)** - A planned response to a wildfire given the wildfire's potential fire behavior. The objective of initial attack is to stop the spread of the fire and put it out at least cost. An aggressive suppression action consistent with firefighter and public safety and values to be protected.

**Prescribed Fire** - Any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met, prior to ignition.

**Prescribed Fire Burn Plan** - A plan required for each fire application ignited by management. Plans are documents prepared by qualified personnel, approved by the agency administrator, and include criteria for the conditions under which the fire will be conducted (a prescription). Plan content varies among the agencies.

**Prescription** - Measurable criteria that define conditions under which a prescribed fire may be ignited, guide selection of appropriate management responses, and indicate other required actions.

**Pre-suppression** - Activities in advance of fire occurrence to ensure effective suppression action. Includes planning the organization, recruiting and training, procuring equipment and supplies, maintaining fire equipment and fire control improvements, and negotiating cooperative and/or mutual aid agreements.

**Prevention** - Activities directed at reducing the incidence of fires, including public education, law enforcement, personal contact, and reduction of fuel hazards (fuels management).

**Rehabilitation**- Efforts undertaken within three years of a wildland fire to repair or improve fire damaged lands unlikely to recover to a management approved conditions or to repair or replace minor facilities damaged by fire.

**Relative Humidity (RH)** - The ratio of the amount of moisture in the air, to the maximum amount of moisture that air would contain if it were saturated. The ratio of the actual vapor pressure to the saturated vapor pressure.

**Size-up** - The evaluation of the fire to determine a course of action for suppression.

**Smoldering Combustion** - Combined processes of dehydration, paralysis, solid oxidation, and scattered flaming combustion and glowing combustion, which occur after

the flaming combustion phase of a fire; often characterized by large amounts of smoke consisting mainly of tars.

**Smoldering Combustion Phase** - Phase of combustion immediately following flaming combustion. Emissions are at twice that of the flaming combustion phase.

**Spot Fire** - Fire ignited outside the perimeter of the main fire by a firebrand.

**Spotting** - Behavior of a fire producing sparks or embers that are carried by the wind and which start new fires beyond the zone of direct ignition by the main fire.

**Suppression** - All the work of extinguishing or confining a fire beginning with its discovery.

**Surface Fire** - Fire that burns loose debris on the surface, which includes dead branches, leaves, and low vegetation.

**Surface Fuel** - Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants.

**Wildfire** - An unplanned, unwanted wildland fire including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out.

**Wildfire Suppression** - An appropriate management response to wildfire, escaped wildland fire use or prescribed fire that results in curtailment of fire spread and eliminates all identified threats from the particular fire.

**Wildland Fire** - Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire.

**Wildland Fire Situation Analysis (WFSA)** - A decision-making process that evaluates alternative wildfire suppression strategies against selected environmental, social, political, and economic criteria, and provides a record of those decisions.

**Wildland Fire Use** - The application of the appropriate management response to naturally-ignited wildland fires to accomplish specific resource management objectives in pre-defined designated areas outlined in Fire Management Plans. Operational management is described in the Wildland Fire Implementation Plan (WFIP).

**Wildland Urban Interface (WUI)** - The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

## **B. Decision Alternatives**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

This alternative continues the program approved in the 2002 fire management plan, as updated with new policy. Under this alternative, prescribed fires would be used by managers to reduce fuel hazards, achieve resource management objectives, and simulate natural fire processes. All fires would be monitored closely and implemented in accordance with an approved prescribed fire plan that meets all standards and requirements, and with a specified minimum number of personnel and equipment to execute necessary actions.

All unplanned ignitions would receive an appropriate management response, which might include a suppression response, or other responses, depending on values to protect and potential impacts of actions. No natural ignitions or human caused wildfires would be allowed to burn without an appropriate management response.

Prescribed fire will be used to:

1. Restore early successional vegetation in marsh and upland areas.
2. Restore habitat for declining bird and other wildlife species dependent upon open forest/shrubland/grassland habitats.
3. Assist in eradicating exotic, invasive plants from Refuge lands, including common reed (*Phragmites australis*).
4. Increase cover of native, warm-season grasses.
5. Provide opportunities for wildlife research and adaptive management.
6. Reduce the buildup of heavy fuels, to reduce the likelihood of a catastrophic wildfire event

Hazard fuel reduction would primarily employ prescribed fire on refuge lands with limited use of mechanical methods. Without an established monitoring plan to trigger re-treatments, they could be delayed until necessary to develop and seek approval and funds for a new project plan for extensive re-treatments in the marsh or for those that would require herbicide to be effective. In addition, a new Environmental Assessment may be required at that future date.

### **Alternative B - Current Wildland Fire Program with WUI Fuels Management (Preferred)**

All of the programs and activities as described above would continue. In addition, a program for continued monitoring and treatment of hazard fuel zones near the three WUI communities would be formally included in the Fire Management Plan. This would continue fuel management practices in primary treatment Zones (Zero Tolerance Zones) and secondary treatment Zones (Limited Tolerance Zones) to continue reduction of hazard fuels with reduced threat to the nearby WUI communities. The primary treatment Zones consist of six non-contiguous polygons with a total of approximately 800 acres. The secondary treatment Zones consist of eight non-contiguous polygons with a total of approximately 2,000 acres.

Rather than targeting only *Phragmites australis* in the primary and secondary treatment Zones, all fuels could be reduced as needed (*Phragmites* representing the highest degree of hazard), to maintain a buffer zone securing the effort invested in 2002 and 2003. It is expected that on-going treatments will continue to be required including use of herbicide,

mechanical methods such as mowing and chain saws (for example), and prescribed fire. Treatment areas should be relatively small (up to 300 acres annually but typically in patches less than 50 acres each, and most likely not the same acreage every year) and treatments completed over the course of days and weeks rather than months and years. Funding for recurring treatments, while not guaranteed, is likely and is expected to result in lower costs over the long term than what is described as the current program.

Objectives of the WUI Treatment Program would be:

- For **primary treatment zones**, maintain hazard fuels (live and dead) at reduced levels in identified buffer zones west of each of the three beach communities adjacent to the refuge and along respective access roads -- by modifying vegetation, fuel loading and fuel characteristics and reducing or eliminating *Phragmites* to the most feasible extent possible. This may include total elimination in some areas, and allowance for small patches (up to ten acres) in others, with a treatment cycle ranging from one to three years for any given site.
- For **secondary treatment zones**, maintain hazard fuels (live and dead) at reduced levels in the zones – by modifying vegetation, fuel loading, and fuel characteristics (including reduced and/or eliminated *Phragmites* cover and stem density within the sampled population) to assist in protection of the three beach communities as well as other WUI areas along the western and northern boundary of the refuge.

The eastern edge of the polygons making up the primary treatment zones, when combined, extends for more than six (6) miles along the marsh near the adjacent beach communities. The eastern edges of the polygons making up the secondary treatment zones, when combined, extend even further. (See the map in Appendix C.)

Methods of assessment for Primary Treatment Zones will be visual inspection and photos. Photos and transect data will be used for Secondary Treatment Zones. Values empirically derived from monitoring response to spraying, burning, and/or mowing regimes will provide quantitative “control criteria” for setting thresholds for localized *Phragmites* growth characteristics in primary and secondary treatment zones. These values will be fine-tuned over time as more data obtained through monitoring is obtained and analyzed.

### **C. Alternatives Considered but Rejected**

#### **Appropriate Management Response to Wildfires Only**

Using only prevention and suppression of all unplanned ignitions would preclude use of prescribed fire or other treatments to reduce hazardous fuels in WUI or non-WUI areas or manage habitats and native plant communities and it would preclude any activity to maintain zones with reduced fuels near the WUI communities; in fact, it would work against habitat management objectives by reducing habitat diversity and allowing the build-up of fuels which could result in more severe wildfires, damaging sensitive plant communities. Hazard fuel loadings would continue to build, posing serious threats to adjacent residents and communities. Large wildfire operations could cause significant adverse impacts which can be limited by fuels management at lower overall cost and with lower risk of catastrophic wildfire.

**Wildland Fire Use (in combination with AMR and Prescribed Fire)** – While there can be ecological benefits that accrue from a practice of allowing naturally occurring fires to burn in predetermined areas under favorable conditions, the low incidence of natural ignitions, the small size of the refuge, the public safety issues associated with the WUI areas along the refuge boundaries, and the limited initial response capability of the refuge present formidable obstacles to implementation of such a practice, precluding any further consideration as a management alternative.

### **Limiting Techniques and Tools of the WUI Treatment Program**

It is to be expected that some hazard fuels treatment techniques and tools will find stronger advocates and detractors among employees, partners, community members, and the general public. Successful maintenance of hazard fuel reduction zones near the WUI communities demonstrates that a combination of treatment types is needed. Restricting use of tools beyond pre-existing administrative constraints is counter-productive. All are needed for effective treatment.

Prescribed fire is an ecological tool but its use presents safety concerns and it produces smoke, which must be managed. Burn Plans are written and approved by managers to ensure a safe environment for those participating in the project and to set limits on areas to burn and conditions when ignition is allowed. Techniques may be employed to reduce smoke emissions by maximizing burning in the flaming phase of combustion and minimizing burning in the smoldering phase. Prescribed fire in the right conditions can reduce hazardous fuel loads and modify fuel characteristics very effectively, at relatively low cost, and also stimulate native fire-adapted species. A lesson learned in the course of monitoring the WUI project was that fire stimulated *Phragmites* re-growth density increased on higher salinity sites, while it did not do so on sites with more freshwater. It was found that prescribed fire by itself cannot do the job, and in some cases, should be avoided.

Where habitats are outside the normal range of variability (species composition and structure) because of invasion by non-native species or build-up of debris and other fuel, such that native plants cannot emerge, multiple prescribed fire treatments, possibly in combination with other treatments, can address these conditions, as was initiated at Prime Hook refuge in 2002.

Herbicide use is objectionable to some on general principles; others may object to aerial spraying with fixed wings, but not to aerial spraying from helicopters, which can hover near the ground and direct the application to small, critical areas. Some may consider application from the ground acceptable, although it might not be very effective for large areas. Fixed wing, helicopter, and ground application may all be appropriate for different sites. Ground spraying requires access by people or equipment to the application site. Aerial application overcomes that obstacle, but is more costly and requires favorable wind conditions during the planned treatment time (as does ground spraying).

Herbicides approved for use on National Wildlife Refuges receive scrutiny at regional and national levels to ensure that products used will be safe and effective and have no

long term impacts. Licensed contractors and employees are required to follow procedures outlined on Materials Safety Data Sheets for handling the chemicals.

The aquatic herbicide Rodeo (glyphosate) has been demonstrated to be an effective tool for reducing *Phragmites* density and cover at Prime Hook NWR when applied by aerial spraying from mid-August to mid-October. Application was at a rate of 2 quarts per acre in a water mixture also containing an approved surfactant. Typically, prescribed fire is then used to remove the dead canes resulting from the treatment. A second herbicide application follows, in the next year, to provide optimal control. Since *Phragmites* can re-sprout from rhizomes that can extend over 100 feet from a stem and can also re-colonize a site from water-borne seed, treatment of large areas is preferred for significant removal of this hazardous fuel and exotic plant. Mowing and other mechanical treatments are effective in small patches, but are not suitable to treat large areas. Like ground application of herbicide, their use requires access by the equipment and the equipment operator. Access to the marsh fuels where the WUI work is needed is limited.

Use of herbicides over the whole marsh mitigated the hazard 90% or more by eliminating and reducing the primary hazard fuel. Treatment of only a portion of the marsh could have resulted in rapid re-colonization from nearby areas. To control re-sprouts or any new infestations, treatment of small patches is needed to maintain the favorable restoration outcome of the 2002 – 2004 treatment regime. On-going periodic treatment of targeted patches can prevent a need to re-treat the whole marsh at some future date and in the meantime can help maintain its ecological integrity.

The ability to use several available treatment types singly and in combination is critical to effective fuels management to reduce the risk of wildfire impacting the three WUI beach communities at Prime Hook NWR. Anything less than use of a full toolbox would defeat the purpose of the investment already made to eliminate and reduce hazard fuels in the identified treatment areas.

Ailstock et al. (2001) compared two treatments in *Phragmites* dominated sites: glyphosate application alone (in October) and glyphosate application (October) followed by dormant-season burning. These researchers found that burning favored a more rapid re-establishment of other marsh vegetation, with increases in species abundance and diversity: “these treatments thus appear capable of returning *Phragmites*-dominated wetlands to a pre-colonization condition for 2 to 3 years. After the third growing season, expansion of *Phragmites* not killed in the initial application was significant. Therefore, additional spot applications of herbicide are needed to prevent re-growth of *Phragmites* in the long term...burning does favor the rapid re-establishment of non-target vegetation and likely restores habitat and wetland functions.”

Other studies have indicated that summer burning, in contrast to spring and fall, resulted in stunted shoot growth, and was recommended for controlling vegetative growth of *Phragmites* plants (Thompson & Shay – 1984). Burning in mid-summer created the greatest disruptions to the plant’s growth cycle.



Herbicides other than glyphosate may be scientifically demonstrated to be more effective than the ones currently used. This alternative would allow such products to be used, subject to the approval and use requirements noted above.

#### **D. Mitigation Measures for the Proposed Action**

The measures below will be implemented with either alternative proposed.

##### **1. Smoke Management Practices for Prescribed Fires**

The following steps will be taken to mitigate impacts of smoke from prescribed fires:

Smoke sensitive areas will be identified and addressed in an Annual Prescribed Fire Burn Plan which includes all units where prescribed fire will be used. Smoke management will be included in operational briefings. Selection of wind direction vectors for individual treatment units and subsequent monitoring and constraints on implementation will avoid impacts.

No burning will occur when an air regulatory agency has issued an air pollution health advisory, alert, warning, or emergency for the area surrounding the Refuge.

A test burn will be used to determine if conditions are favorable for ignition, as prescribed.

During implementation, backing and flanking fires will be used when possible to reduce emissions.

All prescribed fires will comply with smoke and air quality management regulations of the State of Delaware Department of Natural Resources and Environmental Control (DNREC) Air Quality Management Section.

##### **2. Protection of Sensitive Species/Resources**

Endemic species distribution information will be reviewed when evaluating resources at risk to reduce impacts from fire management activities on sensitive species or habitats.

Available inventories and information concerning cultural resources will be consulted prior to implementing fire management activities with potential adverse impacts to cultural resources.

AMR will be used and minimum impact suppression techniques (MIST) will be employed as much as practical. Natural and artificial barriers will be used as much as possible for containment. When a fire line is needed, it will be constructed in such a way as to minimize long-term impacts to resources by careful planning and use of MIST. Damages resulting from suppression actions will be repaired by suppression resources as soon as possible after control of the fire.

Suppression tactics that may have long term environmental impacts will be limited, including use of retardant or heavy equipment in non-life-threatening situations without the specific approval of the Refuge Manager. In all cases, use of retardant chemicals and foams will not occur within 300 feet of any water body or ditch, effectively limiting use of retardant to upland areas.

Refuge staff will work with Incident Commanders to limit disturbance to culturally significant areas; these areas are small and this should not significantly impact firefighting.

When wildfires cause impacts within burned areas not likely to be restored through natural processes, an emergency stabilization and/or burned area rehabilitation plan will be developed and applied.

### **3. Proposed Future Changes in Interagency Wildland Fire Management Policy**

The following statement is included in section 3.1.2 of the 2009 FMP: “A number of revisions to the ‘Interagency Strategy for the Implementation of Federal Fire Management Policy (2003)’ are expected to be adopted during the 5-year life expectancy of this Plan. Changes which may be anticipated include

- Management of wildland fires for more than one objective.
- Assessment of all wildfires using the Wildland Fire Decision Support System (WFDSS) and discontinuation of the Wildland Fire Situation Analysis (WFSA).
- Escaped prescribed fires which are declared wildfires will be given the same assessment as any other wildfire.
- Re-assessment of policy regarding the management of human-caused wildfires.

Until these changes are officially adopted by the Federal agencies, and implementation direction provided, there will be no change at Prime Hook NWR in how wildland fires are managed. However, it should be understood that any mandatory changes in Federal wildland fire policy will be automatically adopted by the Refuge without requiring an immediate revision to this FMP.”

### **III. The Affected Environment**

#### **Location, History, and Climate**

Prime Hook National Wildlife Refuge was established in 1963 under the authority of the Migratory Bird Conservation Act to preserve and protect coastal wetlands as migrating and wintering habitat for migratory waterfowl. Today the refuge hosts thousands of ducks, geese, and shorebirds each year, and provides habitats for other species like the endangered Delmarva Peninsula Fox Squirrel. The goal of refuge management is to provide habitat for a diversity of native fish, wildlife, and plants in the mix of wetlands and uplands on the refuge lands.

The refuge is in Sussex County Delaware along the southwestern shore of Delaware Bay. It is about 12 miles southeast of Milton and 10 miles northwest of Lewes. The refuge headquarters is 1.6 miles east of State Highway One near the community of Milton. The refuge and surrounding area are within two hours drive time of Baltimore, Maryland, Wilmington, Delaware, and Washington D.C.

Historically, the area surrounding the refuge has been dominated by agriculture, with corn, soybeans, and wheat the main cash crops. During the 1980's and 1990's, extensive beach development began nearby, including vacation homes, retirement communities, golf courses, and shopping malls. The eastern boundary of the refuge is adjacent to three beachfront communities: Slaughter Beach, Prime Hook Beach, and Broadkill Beach. These are accessed by four paved roads from State Highway One, a scenic coastal route.

Nearly all the refuge lies below 10 foot mean sea level and includes extensive fresh and brackish wetlands and salt marshes. The refuge currently comprises about 10,132 acres, including easements, of which 9,462 is considered burnable. A table of refuge habitats and their extent is included in Table 2 on page 21.

Delaware's Piedmont and coastal plain ecosystems have had a long history of disruption by human activities (Mackenzie et al. 2000.) Delaware has experienced more extensive landscape alteration than any other region in the U.S., with historic rates of species loss among the highest in the continental United States. Strong development pressure continues, with rapid transitions of forest and farmland to residential, commercial, and industrial infrastructure development. Between 1974 and 1984, Delaware had a 15.4% net loss of coniferous forest and a 7.1% net loss of deciduous forest to both farming and development; a 1.2% net loss of farmland (with large gross losses of farmland to development mostly offset by gross gains of farmland from forest); and a 4.5% net loss of coastal wetlands (Mackenzie 1989). Between 1992 and 1997, Sussex County had the largest gross loss of forests (-17,000 acres) of the three Delaware counties. This loss resulted from the largest percentage gains in residential acreage and in other urban uses in the state (Delaware Department of Agriculture, Forest Service 2001).

The climate is temperate and humid, with cool winters and warm summers. Monthly mean low temperatures are below freezing only in January and February; the coldest period typically lasts a maximum of 2-4 weeks. Summers are hot and humid, with

monthly mean high temperatures (Fahrenheit) in the 80's, with occasional 90 degree days that can occur from April to October. The maximum recorded high temperature exceeded 101 degrees. Snowfall is extremely variable and may be non-existent or as much as 15 inches in one day. Median annual precipitation is just over 44 inches, normally well distributed throughout the year. (Data from NOAA Climatology Report -- Lewes, DE.)

## **A. Soils and Water**

Soils vary from marine tidal marsh soils in salt marshes, organic soils in freshwater wetlands, to a variety of sandy loams in the uplands. Swamp soils are various mixtures of sand, silt, and clay, all generally stratified but with no profile development. Tidal marsh soils are variously stratified with no profile development, often with buried peaty horizons. Upland areas are comprised of loams, representing five series and ranging from well to poorly drained. Upland soils belong to the Fallsington and Sassafras series.

The refuge contains three large, brackish and freshwater management units managed by a series of water control structures. Current habitat objectives focus on creating conditions to grow desirable vegetation which can be flooded for optimal feeding conditions for a variety of migrating and wintering waterbirds, including waterfowl, shorebirds and wading birds. Consideration is also given to other wetlands-dependent species, such as reptiles, amphibians, and invertebrates, but the primary management emphasis is on providing optimum habitat for wetland-dependent migratory birds.

## **B. Habitat, Vegetation, and Fuels**

### **Upland habitats**

Most of the moderately to well-drained portions of the refuge were farmed for more than 200 years. These areas typically pose little fire hazard, due to light fuel loading and short vegetation. Some cropland has been left fallow and may be allowed to revert to natural communities, maintained in early successional seral stages of native grasses or shrubs, or restored to native habitat for the Delmarva fox squirrel.

Timber and brush areas are seral stages that developed from field abandonment during the 1900's. Shrublands are dominated by coastal species such as wax myrtle (*Myrica cerifera*), marsh elder (*Iva frutescens*), groundsel tree (*Baccharis halimifolia*), button bush (*Cephalanthus occidentalis*), red cedar (*Juniperus virginiana*), and others. (See the refuge Habitat Management Plan for complete list). Fire typically initiates by burning the litter under brush or trees. Wax myrtle contains flammable aromatic compounds, making it a potential fire hazard. Red cedar foliage is also highly flammable.

Forested areas are usually seasonally wet habitats. These areas are dominated by red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), several species of oak (*Quercus* spp.), and sweet gum (*Liquidambar styraciflua*). Drier sites also contain loblolly pine (*Pinus taeda*) and Virginia pine (*Pinus virginiana*). Fuel models are generally model 8 and 9. Some areas contain extensive, dense vine growth in the understory, and dead lower branches, contributing to ladder fuels.

## Wetland Habitats

The tidal salt marshes on the refuge are dominated by two basic plant associations. In the regularly flooded portions, saltmarsh cordgrass (*Spartina alterniflora*) dominates, while in the irregularly flooded areas the dominant plants are the grasses collectively known as salt hay (*Spartina patens* and *Distichlis spicata*). Irregularly flooded marshes contain additional plant species, including marsh elder (*Baccharis halimifolia*) and big cordgrass (*Spartina cynosuroides*).

Brackish marshes not invaded by common reed (*Phragmites australis*) are more diverse than salt marshes. They are dominated by species such as cattail (*Typha latifolia*), marsh hibiscus (*Hibiscus moscheutos*), bulrushes (*Scirpus* spp.) and smartweeds (*Polygonum* sp.). Freshwater marshes are the most diverse wetlands, containing pockets of wild millet (*Echinochloa walteri*), wild rice (*Zizania aquatica*), rice cutgrass (*Leersia oryzoides*), sedges (Cyperaceae), smartweeds, and beggar's ticks (*Bidens* spp.).

Extensive wetland areas, in both impoundments and the surrounding natural marshes, have been susceptible to invasion and domination by a non-native variant of the common reed (*Phragmites australis*). This species offers limited cover and little food value for migrating water birds. It can replace diverse wetland plant communities that provide important migratory bird habitat and food resources. Stands of common reed are dense, and can accumulate large amounts of standing dead canes and litter.

Prior to refuge ownership, landowners burned the marshes and adjacent grasslands each spring to prevent encroachment of brush, to maintain a neat appearance, and to improve grazing and haying. This practice resulted in low probability of significant wildfire. Prescribed fire is commonly and frequently used in salt and brackish marshes to enhance productivity (Hackney and de la Cruz 1981), manage food sources for wildlife and cattle, reduce plant cover, reduce fuel loadings, and eliminate woody species such as baccharis (Chabreck 1988), as stated in Brown and Smith (2000).

By 1977, however, brush was seriously encroaching on the marsh and *Phragmites* had replaced other vegetation, resulting in a serious fire hazard and a threat to adjacent lands. The excessive fuel loading has been most problematic in the refuge's freshwater areas, followed by the salt marshes. Since the salinity ranges in the refuge's salt marshes are very low due to the dilution of the tidal flow from the Delaware Bay through Mispillion Inlet, it is impossible to decrease *Phragmites* growth by salinity stressing at Prime Hook NWR. Furthermore, in the 5 to 10 parts per thousand range, *Phragmites* has a competitive advantage over other upland marsh species like *Iva frutescens*, *Baccharis hamifolia*, *Solidago sempervirens*, etc. (Myerson et. al. 2000). *Phragmites* grows to a height of over 14 feet and it spreads by growth of rhizomes that can extend up to 100 feet out from a cane stem. During the non-growing season the above-ground shoots (canes) dry out, creating a fire hazard due to the heavy loading of easily ignited, dry, standing fuel. The canes can persist for up to four years.

Approximately 4,000 acres of the refuge was infested with *Phragmites* prior to restoration and fuel treatments made in 2002, 2003, and 2004. Its extent has been greatly reduced, but it has not been eliminated. *Phragmites* is a relatively good seed producer. Seed dispersed by wind and water can come onto the Refuge from off-refuge sites and quickly establish sprouts on sites with high water tables or seasonally flooded sites.

The following excerpts describe the common reed *Phragmites*, its distribution, the associated fire hazard, and limitations of treatments (Dibble, Zouhar, and Smith 2008:

Common reed, a large, perennial, rhizomatous grass with nearly worldwide distribution, is the invasive species of most concern in tidal wetlands (for example, see Leck and Leck 2005; Niering 1992; Weis and Weis 2003) and also invades fresh wetlands and riparian areas in the Northeast bioregion (table 5-1). Literature reviews (for example, D'Antonio and Meyerson 2002; Marks and others 1993, TNC review) suggest that, although common reed is native to North America, invasive strains may have been introduced from other parts of the world; and while there is evidence that common reed is native in the Northeast bioregion, many marshes are occupied by a European genotype (Saltonstall 2003). Common reed is regarded as aggressive and undesirable in parts of the eastern United States, but it may also be a stable component of a wetland community that poses little or no threat in areas where the habitat is undisturbed. Examples of areas with stable, native populations of common reed include sea-level fens in Delaware and Virginia and along Mattagodus Stream in Maine. In areas where common reed is invasive, large monospecific stands may negatively impact native plant diversity and create a fire hazard (D'Antonio and Meyerson 2002; Marks and others 1993).

Common reed is perceived as a fire hazard where it occurs in dense stands in wetlands. It produces substantial amounts of aboveground biomass each year, and dead canes remain standing for 3 to 4 years (Thompson and Shay 1985). It has been suggested that common reed colonies increase the potential for marsh fires during the winter when aboveground portions of the plant die and dry out (Reimer 1973). Thompson and Shay (1989) observed that, even when common reed stands are green, the typically abundant litter allows fires to burn. Additionally, head fires in common reed stands may provide firebrands that ignite spot fires more than 100 feet (30 m) away (Beall 1984, as cited by Marks and others 1993)....

Studies in the north-central United States and adjacent Manitoba, Canada, indicate that common reed is not typically damaged by fire because it has deeply buried rhizomes that are often under water, and the heat from most fires does not penetrate deeply enough into the soil to injure them. When fire consumes the aboveground foliage of common reed, new top growth is initiated from the surviving rhizomes. Rhizomes may be damaged by severe fire when the soil is dry and humidity low (Uchytel 1992b, FEIS review). Fires of this severity are likely to occur only under conditions of artificial drainage and/or severe drought....

Burning is sometimes used in conjunction with herbicide treatments and manipulation of water levels to control common reed. Clark (1998) found that herbicide applied late in the growing season, followed by dormant season prescribed fire and a second herbicide application the following growing season, was more effective than spraying alone. A significant decrease in density and frequency of common reed was recorded in spray-burn treatments compared to pretreatment measures, untreated controls, and spray only treatments (Clark 1998). At Wertheim National Wildlife Refuge in New York, common reed was eliminated from a freshwater impoundment that was drained in the fall, burned the following winter, and then re-flooded. Common reed remained absent for at least 3 years following treatment (Parris, personal communication cited by Marks and others 1993).

The potential for a high severity wildfire in the marshes at Prime Hook NWR presents some significant challenges. The table below contains values that approximate worst case fire behavior characteristics (rate of spread and flame length) in the various refuge habitats, based on typical worst case conditions -- those conditions that occurred during the 2002 Slaughter Beach wildfire of March 10, 2002.

Table 2. Refuge Habitats and Acres, Fuel Types, and Fire Behavior Characteristics

Habitats	Acres	Fuel	Flame Length	Spread Rate
<i>Wetland Habitats 8,409 (82% of total)</i>				
Emergent Marsh	5,367	Tall Grass	>19 feet	257 feet/minute
Marsh Easements	827	Tall Grass	>19 feet	257 feet/minute
Aquatic beds	670	non-burnable	0	0
Scrub/shrub	688	Brush	8.6 feet	75 feet/minute
Forest wetlands	772	Leaf Litter	3.6 feet	14 feet/minute
Sandy Beach	85			
<i>Upland Habitats 1,723 (18% of total)</i>				
Agricultural	650	Short Grass	7.3 feet	280 feet/minute
Deciduous forest	767	Leaf Litter	3.6 feet	14 feet/minute
Coniferous forest	104	Leaf Litter	3.6 feet	14 feet/minute
Deciduous shrub	48	Brush	8.6 feet	75 feet/minute
Grassland	154	Short Grass	7.3 feet	280 feet/minute
<i>Total Acres 10,132 Burnable Acres 9,462(93%)</i>				

The values above should be considered estimates for planning purposes only. Four foot flame lengths are considered the limit for successful direct attack by firefighters with hand tools, and eight foot flame lengths the limit of the control for engines with water streams. The typical worst case can cause significant control problems in continuous marsh fuels and present challenges to firefighters in the other fuel types without the support of water streams or use of advantageous positions such as roads and streams, fuel clearings near structures, etc. Fuel type descriptors and calculated fire behavior characteristics are based on standard concepts and techniques in use (Rothermel 1983).

*Tall Grass (Marsh, approximates Phragmites)*

Fires can burn intensely through standing cured or dead vegetation that is three feet tall or

more. Wind may drive fire across standing water in the tips of vegetation. Fire behavior characteristics are directly related to fuel moisture and wind speed. Flame lengths and short range spotting (to 100 feet) pose serious problems for firefighters. Fires in this fuel type are present safety issues to firefighters because of the fire intensity (flame lengths), the depth of the flaming front, and the difficulty of getting around in the vegetation.

*Short Grass (Grasslands and scrublands where grass would carry fire)*

Surface fires ignite and spread easily through fine, continuous cured grass up to a foot tall. Fire characteristics are directly related to fuel moisture and wind speed. Spotting is generally not a problem, because fuel is burned quickly and thoroughly. Resistance to control is low to moderate, depending on wind speed. The flaming front is usually not very deep.

*Brush 2 to 4 feet in Height (Shrub/scrublands where brush litter carries fire)*

A broad range of shrub conditions may be covered by the description. Live fuels are usually absent, sparse, or have high fuel moisture content, so they don't affect fire behavior. Often wind speeds of 20 mph are needed to carry fire. Fire will drop to the ground at low wind speeds or openings in the stand. Fires in shorter brush that grows more densely in wetlands could present challenges during extended drought.

*Leaf litter (Upland deciduous hardwood or coniferous forest stands)*

Fires move slowly through dead, loosely compacted leaf litter and understory grasses. Fire behavior is directly related to fuel moisture and fuel loading, and to wind speed in and near canopy openings. Wind-blown leaves and fire that burns up into trees may result in short-range spotting that increases spread rates above predicted values. Resistance to control is usually low to moderate, but control and mop-up can be difficult during drought and/or windy conditions.

## **C. Wildlife**

The refuge supports a wide variety of animal species. Three hundred eight bird species are listed, of which 125 are known to nest on the refuge. Refuge habitats also support 51 fish species, 5 shellfish species, 45 herptile species, and 37 mammalian species.

The most conspicuous bird species are waterfowl, which occur in large numbers during the fall and winter. The shallow waters of the impoundments and salt marsh provide excellent feeding areas for numerous species of wading birds including large numbers of clapper rails. Shorebirds use the impoundments, salt marsh and Bay Shore extensively during migration. The concentration of migrating shorebirds which gather in the spring to feed on horseshoe crab eggs is of international significance. The salt marshes function as an important nursery area for several marine species of commercial interest, especially the blue crab, American eel, white perch and rock fish.

The federally endangered Delmarva Peninsula fox squirrel was reintroduced to the refuge in 1986. Life history studies have shown that the squirrel generally prefers an open understory (Moncrief *et al.* 1993); refuge managers in the mid-Atlantic have begun to use



prescribed fire experimentally to enhance forest habitats for Delmarva Peninsula Fox Squirrels.

Both the Delaware and New Jersey shores of the Delaware Bay recently were designated as an International Shorebird Preserve, based on the importance of the estuary to migrating shorebirds. Refuge marshes receive use by shorebirds during both spring and fall migrations. Prime Hook NWR provides habitat for a number of state endangered and threatened species and species of conservation concern. A list of species of conservation concern is in the Refuge Habitat Management Plan.

An overview of fire effects on wildlife is provided in the following sections excerpted from a recent publication on fire effects (Lyon, Telfer, and Shreiner 2000):

Despite the perception by the general public that wildland fire is devastating to animals, fires generally kill and injure a relatively small proportion of animal populations. Ambient temperatures over 145 °F are lethal to small mammals (Howard and others 1959), and it is reasonable to assume the threshold does not differ greatly for large mammals or birds. Most fires thus have the potential to injure or kill fauna, and large, intense fires are certainly dangerous to animals caught in their path (Bendell 1974; Singer and Schullery 1989). Animals with limited mobility living above ground appear to be most vulnerable to fire-caused injury and mortality, but occasionally even large mammals are killed by fire....

Fire may threaten a population that is already small if the species is limited in range and mobility or has specialized reproductive habits (Smith and Fischer 1997)....

Direct fire-caused mortality has been reported for large as well as small mammals, including coyote, white-tailed deer, mule deer, elk, bison, black bear, and moose (French and French 1996; Gasaway and DuBois 1985; Hines 1973; Kramp and others 1983; Oliver and others 1998). Large mammal mortality is most likely when fire fronts are wide and fast moving, fires are actively crowning, and thick ground smoke occurs....

Further information related to various vegetative communities is excerpted from Lyon, Brown, Huff and Smith (2000):

In grasslands, the pre-fire structure of the vegetation reasserts itself quickly as a new stand of grass springs up from surviving root systems. Standing dead stems and litter are reduced. The proportion of forbs usually increases in the first or second post-fire year. In about 3 years the grassland structure is usually reestablished (Bock and Bock 1990), and faunal populations are likely to resemble those of the pre-burn community. Repeated fires can convert some shrublands to grass, and fire exclusion converts some grassland to shrubland and forest....

It would be difficult to overestimate the importance of large trees, snags, and dead, down wood to North American birds and small mammals. (Brown and Bright 1997).

The snag represents perhaps the most valuable category of tree-form diversity in the forest landscape.” Fire and snags have a complex relationship. Fires convert live trees to snags, but fires also burn into the heartwood of old, decayed snags and cause them to fall. Fire may facilitate decay in surviving trees by providing an entry point for fungi, which increases the likelihood that the trees will be used by cavity excavators. Fire may harden the wood of trees killed during a burn, causing their outer wood to decay more slowly than that of trees that die from other causes. This “case-hardening” process reduces the immediate availability of fire-killed snags for nest excavation but slows their decay after they fall. It is difficult to identify fire-injured trees that are likely to become snags, and it is also difficult to determine which snags may have the greatest “longevity,” that is, may stand the longest time before falling....

The usefulness of snags to fauna is enhanced or reduced by the surrounding habitat, since cavity nesters vary in their needs for cover and food. Many cavity excavators require broken-topped snags because partial decay makes them easier to excavate than sound wood (Caton 1996). Some bird species nest only in large, old snags, which are likely to stand longer than small snags (Smith 1999). Pileated woodpeckers are an example. Some excavators and secondary cavity nesters prefer clumps of snags to individual snags, so the spatial arrangement of dead and decaying trees in an area influences their usefulness to wildlife (Saab and Dudley 1998).

Dead wood on the ground is an essential habitat component for many birds, small mammals (fig. 4), and even large mammals, including bears (Bull and Blumton 1999). Large dead logs harbor many invertebrates and are particularly productive of ants; they also provide shelter and cover for small mammals, amphibians, and reptiles. Fire both destroys and creates woody debris. While large, down logs are not always abundant in early post-fire years, fire-killed trees eventually fall and become woody debris. Down wood from fire-killed trees often decays more slowly than wood of trees killed by other means (Graham and others 1994).

#### **D. Social/Economic – Visual/Aesthetic Factors**

The landscape surrounding Prime Hook NWR is primarily agricultural, dominated by small woodlots, farm fields, and small vacation or retirement communities. Sussex County, DE, which contains the refuge, has a population estimated at about 185,000 (Delaware Economic Development Office). The county is relatively sparsely populated; the largest towns in the area include the county seat, Georgetown, and the resort areas of Lewes, and Rehoboth Beach. Over 100,000 seasonal visitors come to the County each year. (Sussex County Profile 2001.)

Agriculture and beach tourism are the dominant businesses in Sussex County, accounting for primary employment as well as spin-off employment in support industries such as farm machinery, fertilizers, and grain elevators. According to the Delaware Department of Agriculture and chicken industry trade association Delmarva Poultry Industry Inc., 71 percent of the state’s cash farm income was from broiler chickens in 1999, with most of

that coming from Sussex County. Delaware produced 251,700,000 broilers last year, down three percent from the previous year, ranking it ninth among the states in the number of broilers produced. Tourism is the county's second largest industry, with beach development rapidly increasing in Sussex County (Sussex County Profile 2001).

### **E. Cultural Resources**

Few cultural resources have been located on the refuge. There is a small cemetery plot and rubble from a fallen structure near the headquarters area.

### **F. Air Quality and Smoke Management**

Refuge prescribed burning typically is done in fine fuels which burn out quickly with no smoke impacts. Prescribed fires will comply with local, state, and national regulations, as required by Section 118 of the Clean Air Act, as amended (42 USC 7418). The Clean Air Act is intended to regulate planned emissions, including temporary impairments.

The purpose of the Clean Air Act is to protect humans against negative health or welfare effects from air pollution. National ambient air quality standards (NAAQS) are defined in the Clean Air Act as amounts of pollutant above which detrimental effects to public health or welfare may result. NAAQS have been established for the following criteria pollutants: particulate matter (PM10 and PM2.5; NAAQS for particulate matter are established for two aerodynamic diameter classes: PM10 is particulate matter less than 10 microns in diameter and PM2.5 is less than 2.5 microns in diameter (Sandberg et al., 2002).

The Air Quality Management section of the State of Delaware Department of Natural Resources and Environmental Control (DNREC) manages compliance with the Clean Air Act within Delaware. An Application for Prescribed Burning must be submitted by mail or by fax prior to prescribed fire ignition. The form is on the DNREC Internet site at <http://www.awm.delaware.gov/AQM>.

Air quality in Sussex County ranges from good to poor depending on various circumstances. Smoke management is critical because of federal non-attainment areas in the region. On-shore circulation and inversions can result in extended periods of poor air quality, which can occur anytime during the year, especially in the summer.

The main factors affecting emissions from wildland fires are the size of the burn area, the characteristics of the fuel being burned, and the amount of fuel being consumed in the various phases of combustion. The impacts of smoke on human populations are affected by wind direction and speed and the effect of the atmosphere on smoke behavior. Smoke can have serious health effects on members of the public, especially those with pre-existing respiratory problems. Reduced visibility caused by smoke may contribute to vehicle accidents. Areas for attention at the refuge include highways and towns west of the refuge, the beach communities to its east, and the routes to those communities.

Best management practices for smoke include minimizing particulate emissions, wind-borne dispersion and dilution, and avoiding impacts to smoke-sensitive sites. Smoke management will be incorporated into prescribed fire planning and, to the extent possible, the management of wildfires. Sensitive areas will be identified and precautions taken to safeguard visitors and neighbors.

### **G. Visitor Use and Safety**

The predominant public uses of the Refuge are wildlife observation and photography, fishing, hunting, and environmental education. Most visitor use facilities and trails are near the headquarters area, but there are many opportunities for dispersed recreation. There are several boat launch sites, 15 miles of canoe/kayak trails, four interpretive walking trails, a photography blind, a ½ mile wheelchair-accessible board walk and observation platform. The refuge is open to fishing and deer and waterfowl hunting, subject to refuge restrictions and state regulations.

### **H. Wildland-Urban Interface**

Three communities (the incorporated village of Slaughter Beach and the unincorporated villages of Prime Hook Beach and Broadkill Beach) lie along the eastern boundary of the Refuge. Combined, the communities contain nearly 750 homes with median values of \$250,000 – 300,000. Currently more than 60% of these homes are permanent, year-round residences, with the remaining homes used seasonally from April to November.

These communities are protected by the Memorial Fire Department of Slaughter Beach and the Milton Fire Department, which has protection responsibility for Prime Hook Beach and Broadkill Beach. The communities lie at the end of narrow two lane roadways which restrict access for firefighting and for evacuation.

Within the beach communities, narrow lanes that restrict access by fire equipment, small lots, and lack of defensible space between flammable vegetation and structures (typically recommended as 50 to 100 feet) increase potential for catastrophic fires. A fire on the roof of one house will quickly produce embers likely to land on nearby vegetation, and other roofs, decks, and siding) to involve multiple structures. Lack of defensible space, fire hydrants, and access are serious challenges to the fire departments in attempting to safely handle such fires. One control strategy might be to use water streams to reduce spotting from homes already on fire and protect exposures until extinguishment. Given the high winds likely during such an event, use of aircraft may be very limited.

Many of the homes lie immediately adjacent to the refuge's marshes and can be directly affected by refuge fires. Because the spotting distance for fires in *Phragmites* may typically reach 100 feet up to 1,000 feet ahead of a flaming front, nearly all the homes in these communities could be at risk. Many homes are built on elevated platforms to meet flood plain regulations and have increase fire danger from flammable vegetation under these platforms. Several homes have cedar shingle roofs, cedar siding, attached wooden decks, or nearby dense red cedar stands. The narrow roads and lanes could be blocked by

fire apparatus, limiting evacuation. On the plus side, residents of each community have access by foot to fire safe areas along Delaware Bay, to which they could be evacuated.

The alignment of the beach communities is such that a cold front passage in late fall, winter, or early spring when the hazardous fuels on the refuge can readily ignite and burn, will almost immediately threaten the beach communities as it moves with flame lengths and rapid rates of spread estimated in the table in section III B.

The isolated nature of the communities and their surroundings allows for arsonists to avoid detection. If there are strong westerly winds and the marsh is dry, fire will spread from the point of origin and into the marsh toward the beach communities. Firefighting will be hampered by lack of access in the marsh. The proximity of homes will preclude use of tactics and strategies that involve extensive firing. Some limited firing may assist in fire control along the main roadways in, as on the Slaughter Beach fire.

An important component of protecting lives and homes in the WUI areas is education of homeowners and landowners by federal, state, and local partners to encourage them to mitigate the hazards they can by removing vegetation and using building materials that are more fire-resistant than cedar shakes, for example, cleaning leaf and needle litter from roofs and eaves, and ensuring vents are screened to prevent embers from entering a home.

In addition to the beach communities, homes and outbuildings are scattered along the refuge's western boundary, mostly adjacent to woodlands or small marshes. Elements of the above scenarios apply to these other WUI areas; however, the problems of congestion and multiple structures, lack of access and isolation are all moderated. Furthermore, except in very rare events, these areas are not aligned with the westerly and northwesterly strong winds associated with a cold front passage. This does not suggest that there is no threat to life and homes from other wildfires with less rapid spread and less intensity, especially if there is no break in fuels from nearby flammable vegetation.

The Refuge headquarters is located at the end of Turtle Pond Road. Maintenance facilities are nearby, some with narrow access roads. There are other visitor facilities in this area. This area has a less advantageous position in terms of wind than those positions along the western boundary, but it is not fully exposed to the threat because the fuels on the surrounding lands are not likely to result in fires which cannot be controlled by responding forces, taking advantage of roads, streams, and other natural barriers to fire spread.

## **IV. Analysis of Selected Alternatives and their Environmental Consequences**

### **A. Soil and Water Resources**

#### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

The unplanned nature of wildfires and their potential for accidental or intentional ignition by arson or carelessness means that they occur often during periods of high to extreme fire danger, when environmental conditions favor the development of large, severe, and potentially wildfires. The appropriate management response to wildfire may involve mobilization of heavy equipment and crews, fire line construction, use of unpaved roads and tracks, and associated activity which can cause more damage to soils and water quality than a wildfire itself. An appropriate management response considers those potential outcomes, among others, in selecting strategies and tactics which may range from aggressive initial attack and suppression action to a modified attack, including confinement; i.e., allowing a fire to burn out in the marsh, for example, when and where it will lead to effective containment and control. It also provides for various strategies and tactics to be used on different flanks of the same fire. AMR on the refuge will be accompanied by use of minimal impact suppression tactics, to minimize potential suppression impact, and by repair of suppression-caused damage.

Prescribed fires typically have minimal impacts on soil because the fire area, ignition timing, and fire intensity are all subject to the limits of an approved prescribed fire plan, which is followed in implementation. Direct soil impacts would result from preparation activities such as fire break construction, without the use of heavy equipment or large crews. Prescribed fires in woodlands typically maintain vegetative cover, with few impacts. In grasslands and marsh, there may be little difference between a wildfire and a prescribed fire in terms of their impacts.

Maintaining vegetative cover provides water quality benefits by reducing runoff and associated sedimentation. High intensity wildfires can result in high fire severity, with increased soil erosion and siltation impacts due to greater damage to vegetation and root mats below the soil surface. If this were to occur, mitigation might be made through post-fire Emergency Stabilization and Rehabilitation. Low and mixed-severity wildfires or typical prescribed fire would likely result in minimal soil erosion and runoff problems due to lower impacts to vegetation and root systems.

Preparation and planning for herbicide and mechanical treatments must meet agency requirements to minimize any potential impacts. Waiting for a potential problem to develop in maintaining the no tolerance and zero tolerance treatments zones can result in a larger treatment footprint at any one time, opening the door for larger impacts.

**Alternative B – Current Wildland Fire Program with WUI Fuels Management (Preferred)**  
Impacts of AMR activities as described above in Alternative A may be somewhat minimized since the WUI treatment program will result in reduced threat of wildfire and

its extent on a more continual basis. As a result, a wider range of potential AMR actions will be available to Incident Commanders to apply on marsh fires because of the reduced fuel loads. This will likely result in need for fewer apparatus and firefighters, lowering impacts associated with a wildfire. It may be possible to manage a wildfire in the marsh approaching the communities without having to evacuate residents. While access will always be a problem, maintaining significantly reduced fuel loads will reduce fire intensity and impacts on soils.

Furthermore, it is probable that more fires will be controlled at smaller sizes because the fuels will become patchier and less continuous over time. Direct impacts on soil and water are likely to be less than in Alternative A.

Maintaining less flammable vegetative cover will continue to provide water quality benefits by reducing runoff and associated sedimentation. Low and mixed-severity wildfires resulting in minimal soil erosion and runoff problems due to lower impacts to vegetation and root systems are more likely in this alternative than in A.

The benefits of using prescribed fires are similar to Alternative A. Reduction of fuels by other means will allow more opportunities for prescribed fire use. Preparation and planning for herbicide and mechanical treatments must meet similar requirements as for prescribed fires, to minimize any potential impacts. Treatments in this alternative would have a smaller footprint at any one time, minimizing any potential impacts.

## **B. Habitat, Vegetation and Fuels**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

Certain treatment areas are identified and selected annually for burning and other treatments to fulfill specific management goals and objectives. Use of prescribed fire would likely reduce hazardous fuels and increase vegetation diversity. Increased Refuge plant diversity and reduction of nuisance and non-native vegetation would result, in some cases. Reduction of fuels would also lessen the potential for wildfires in the treated areas. However, prescribed fire alone may increase *Phragmites* cover. The impacts of AMR operations would be similar to those described in the soils and water analysis.

### **Alternative B – Current Wildland Fire Program with WUI Fuels Management (Preferred)**

Pre-determined areas are defined for potential treatment annually, with established monitoring procedures in both primary and secondary treatment areas to determine the extent of treatment needed to maintain the fuel reduction and habitat restoration investments already made. Because treatments include various types and methods, they are more likely to occur and produce reduced hazard fuel loadings and greater cover of vegetation beneficial to wildlife. Alternative A could result in large *Phragmites* infestations before treatment. Provision for on-going treatments as needed provides the most potential treatment benefits with the least impacts. Increased patchiness of the vegetation and fuels over time will also tend to increase habitat and vegetative diversity. This alternative will have a greater positive impact on vegetation and fuels than Alternative A.

## **C. Wildlife**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

Inadvertent destruction of wildlife habitat and disruption to resident wildlife populations could occur with wildfires and AMR operations. Prescribed fires can create more beneficial habitats for wildlife species, subject to fire location, timing, environmental conditions, and ignition patterns, resulting in a patchy mix of low, moderate, and high burn severity. Prescribed fires may be able to stimulate native plant growth, set back succession, increase community diversity, reduce non-native plant species (under certain conditions), and eliminate hazardous combustible fuels. This alternative provides for treatments by prescribed fire and other treatment types to improve and expand habitat in upland areas for the endangered Delmarva Peninsula fox squirrel (DFS).

### **Alternative B – Current Wildland Fire Program with WUI Fuels Management (Preferred)**

This program would maintain the benefits described above, with an added benefit of maintaining the habitat in the WUI and non-WUI treatment areas more consistently. Alternative A is more likely to result in larger wildfires, with somewhat negative, albeit short-term effects, on wildlife. Alternative B is more likely to result in improved wildlife habitat than Alternative A, in part because of improved patchiness and habitat diversity. This alternative maintains the same potential benefits for DFS and has no adverse impacts since the herbicide treatments are in marsh, which is not DFS habitat.

## **D. Social/Economic - Visual/Aesthetic Factors**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

Prescribed burning would reduce some hazardous fuels near structures and reduce potential economic losses from a catastrophic fire. AMR operations typically prioritize responses to areas with people and infrastructure, also resulting in protection of social and economic values to the extent possible. Prescribed burning can potentially reduce the risk of wildfires by creating patchy fuels and is often a cost-effective alternative to other implementation methods.

Areas with sensitive visual resources could be protected during AMR activities. Some visual changes would occur. Prescribed fires would result in minimal impacts to visual aesthetics and are likely to have benefits such as increasing range of vision for recreationists and refuge visitors by reducing fuels.

### **Alternative B – Current Wildland Fire Program and WUI Treatment Program**

This alternative will enhance the AMR and prescribed fire benefits as above, because it will result in greater patchiness of vegetation and reduced fuels near the areas where people live and where there is economic infrastructure, including highways and the scattered areas with structures and homes along the western boundaries. The continuous assessment of treatment needs and on-going treatments assure the benefits of the 2002 - 2004 treatments are retained. This alternative provides greater assurance than Alternative A that the fuel reduction work will be consistently maintained, and there will be little



disruption to local social and economic activities associated with the WUI communities and with other areas along the refuge boundary where new development could occur.

## **E. Cultural Resources**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

Cultural resources susceptible to damage by fire could be degraded by high intensity fires beyond the capability of suppression forces to immediately control, although no such sites are known to exist on the refuge currently. Known cultural resources would receive protection from wildfire under this alternative, as AMR would implement MIST tactics (as described on page 15) and not allow use of heavy equipment. The scheduled use of prescribed fire under this alternative allows the ability to access, locate, and consequently avoid disturbance to cultural resources. The use of prescribed fire to prevent excess fuel accumulation could protect unrecorded cultural resources.

### **Alternative B – Current Wildland Fire Program with WUI Fuels Management (Preferred)**

This alternative provides the same benefits as Alternative A. Use of multiple treatment types allows flexibility in designing treatments that can minimize potential impacts while accomplishing hazardous fuel reduction and habitat objectives. There are several historic sites within the limited tolerance zones. However, no negative impacts are to be expected.

## **F. Air Quality and Smoke Management**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

For prescribed fires, air quality management is assured by compliance with state regulations and permits, as described above in Section II.D, to minimize smoke emissions and potential impacts. Short-term smoke episodes are possible, but fuels reduction by use of prescribed fire can reduce smoke episodes due to large uncontrolled wildfires.

While every effort would be made to safely control wildfires at small size under this alternative, there would be less fuel reduction accomplished over time and consequently larger expanses of untreated, continuous fuels. This alternative is likely to result in more large wildfires that occur during extreme conditions than alternative B, with greater impacts on public health, especially to those who live near the refuge.

### **Alternative B – Current Wildland Fire Program with WUI Fuels Management (Preferred)**

The increased patchiness and changes in vegetation that would occur under this alternative over time will result in less fuel continuity and lighter fuel loading in critical protection areas. This will allow increased efficiency in AMR operations, resulting in smaller fire size, and less emissions and smoke impacts.

The use of other fuel treatment methods in combination with prescribed fire will allow managers to maximize opportunities to use fire on proportionately more dead and cured vegetation than Alternative A, resulting in greater control of prescribed fires, a reduction in particulates and other emissions, and fewer potential smoke impacts.

## **G. Visitor Use and Safety**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

AMR activities during AMR and prescribed fire operations can limit visitor use and access. Smoke can detract from visual enjoyment and further restrict access on roads and trails. The likelihood of larger wildfires in this alternative through less effective fuel reduction means there would be greater impacts on visitor use and safety as one neared the marsh and the beachfront communities, with perhaps little difference in other portions of the refuge.

Activities associated with prescribed fire are accomplished in a safe manner through preplanning and scheduling of work tasks. Trail closures and public information can be provided to advise visitors and neighbors when and where they might be affected. Treatment areas, ignition methods and patterns, and holding plans are designed to control fire intensity and rate of spread, maintain a safe working environment for firefighters, and ensure protection of public and visitor safety.

### **Alternative B – Current Wildland Fire Program with WUI Fuels Management (Preferred)**

The result of decreasing fuel loads and fuel continuity by more effective treatments in the marsh means that this alternative is expected to result in smaller wildfires, which would reduce the impact on visitor use and safety from that of Alternative A. The potential effects of smoke on the roadways through the marsh are likely to be less than in alternative A, especially from wildfire. The mitigation measures noted above for prescribed fire would still need to be applied.

## **H. Wildland Urban Interface**

### **Alternative A – Current Wildland Fire Program (Prescribed Fire and AMR)**

Protection of public health and safety, specifically in regard to the WUI Communities, is not a specific program in the current Wildland Fire Program. Continuing the current program does not take advantage of the lessons learned during the WUI Project implementation and subsequent monitoring. It may or may not result in continued maintenance of the Zero Tolerance and Limited Tolerance treatment zones, since herbicide could not be used. It could result in lack of treatment until there is another large scale fuels build-up before action is taken.

As a result, hazardous fuel reduction near structures, improvements, and refuge boundaries would be limited mostly to that which could be accomplished through prescribed fire. This would have some effect in reducing the risk of loss from a catastrophic fire and could improve some habitat to benefit wildlife.

### **Alternative B – Current Wildland Fire Program and WUI Fuels Management (Preferred)**

This alternative has greater potential to reduce the risk of catastrophic wildfire, prevent the loss of human life and significant property damage or loss to both publicly-owned and privately-owned property. It provides more opportunity to conduct effective hazardous

fuel reduction treatments. It would also enhance the refuge capability to maintain and improve habitats for the benefit of various wildlife species, and for other habitat management objectives. It also provides for a more effective treatment regimen in both the WUI and non-WUI areas, with better fuel reduction over time.

The use of prescribed fire near the beach communities and other dispersed WUI areas is limited by several factors. Burn plans describe the conditions when ignition can occur in order to assure control of the fire. Air quality regulations and atmospheric conditions limit the number of days available for prescribed fire. In some years there will be too much ice and snow for burning to be effective during winter. Ignition patterns are limited by the proximity of homes and potential smoke impacts.

Fuel reduction near WUI areas can best be provided by a combination of treatment types. Because mechanical and chemical treatments near homes are not subject to the same limitations as prescribed fires, the potential of accomplishing fuel reduction is greater, both because there are more tools, but also because there is a bigger “window” during the year when treatment can be done.

## **I. Summary of Environmental Consequences**

In nearly every area of analysis, Alternative B is expected to contribute to effective management of the refuge both for the wildlife and habitat for which the refuge was established and is managed, and for the safety of members of the public who may enjoy the wildlife-related recreational opportunities on the refuge. In addition, it provides for cooperative positive relations with nearby beach communities and neighbors by providing effective means to deal with hazardous fuels on refuge lands. In conjunction with further educational and hazard mitigation efforts by cooperators and private landowners and residents, Alternative B offers a more effective alternative for the wildland fire management program than Alternative A. It can potentially provide greater continuous benefits both for hazardous fuel reduction and for wildlife and wildlife habitat on the refuge, and helps reduce the threat of wildfire impacting existing beach communities and other WUI areas along the refuge boundaries. Alternative B provides for maintaining the significant investment in restoration of the marsh in the period from 2002 to 2004. Over time the benefits of this Alternative should continue to accrue.

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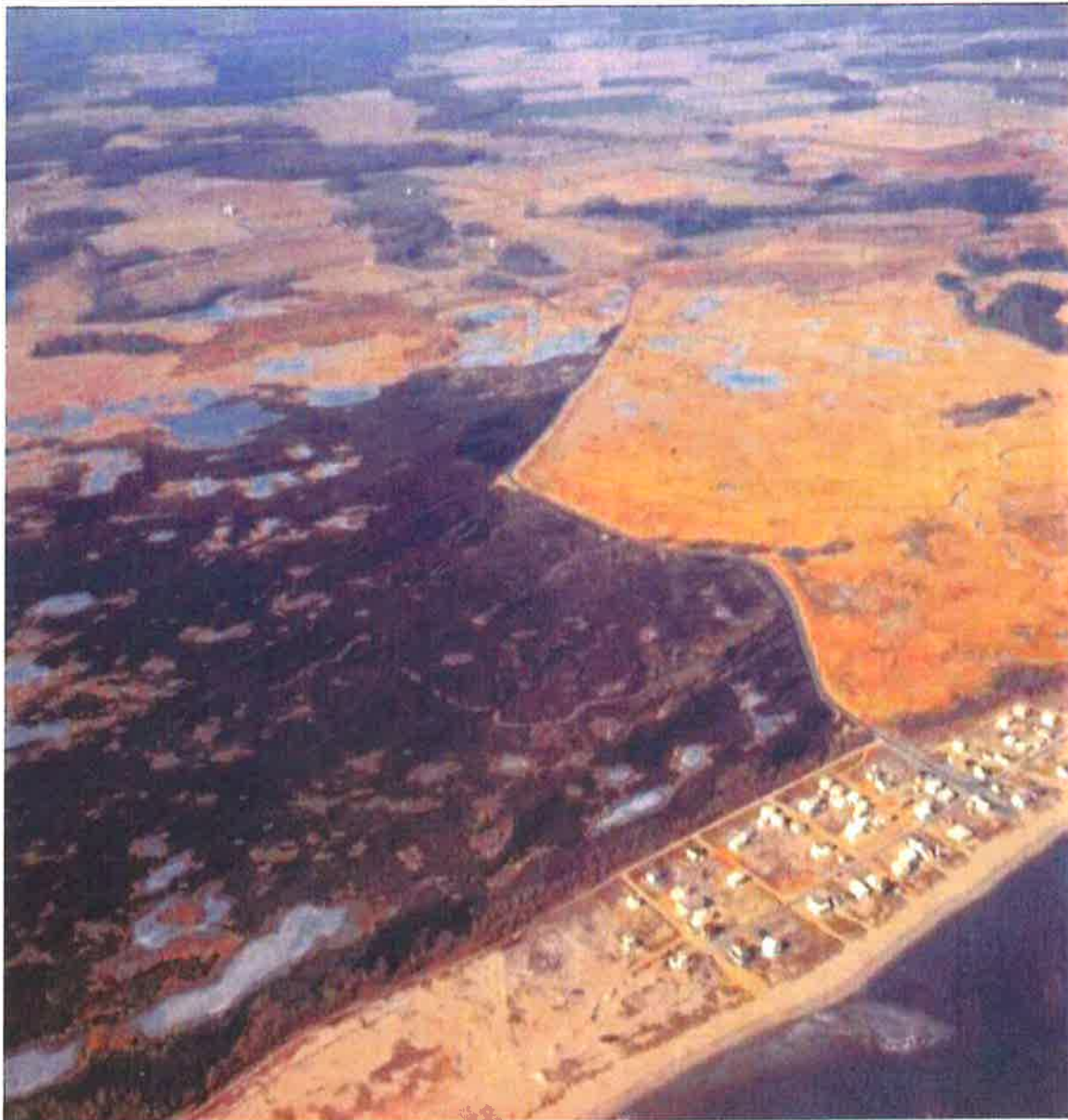


## Appendix B. Wildfire and Prescribed Fire Images

### Slaughter Beach Wildfire, March 10, 2002



Aerial View of part of the area burned by the Slaughter Beach wildfire of March 2002



The shore of Delaware Bay is in the lower right corner. Note the south end of the village of Slaughter Beach in the right lower foreground below the fire-blackened vegetation. The road from Highway One to Slaughter Beach marks the edge of the fire perimeter on the north.

### 2003 Prescribed Fire image

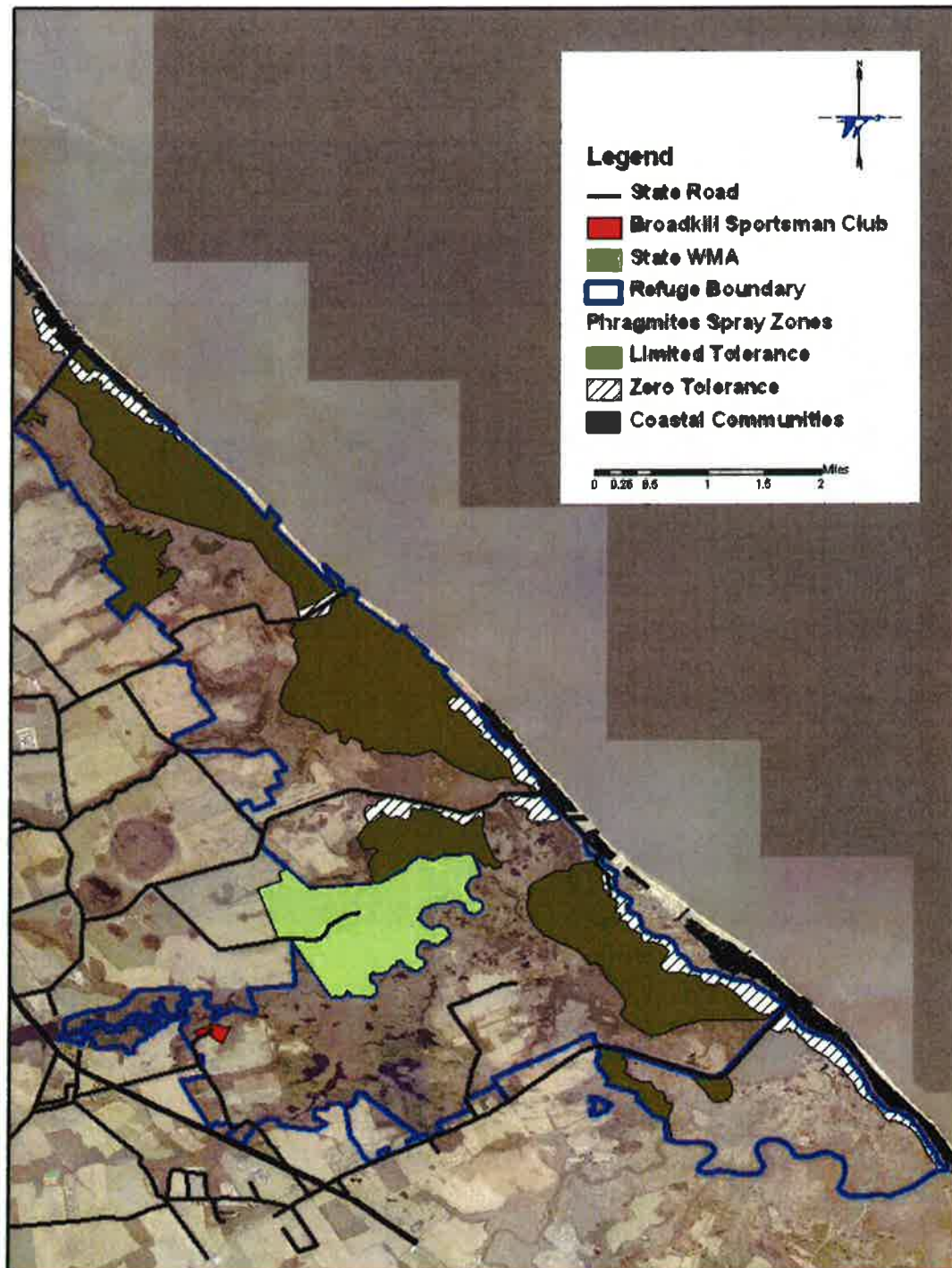
Note the flames are standing near straight up, indicating little wind. Note the differences in the flame lengths within the flaming front, depending on the height of the vegetation burning. Note the black smoke coming from the taller vegetation and that the spread of the fire is being checked by the lack of standing vegetation in a tracked road or matted down vegetation in the lower right corner.



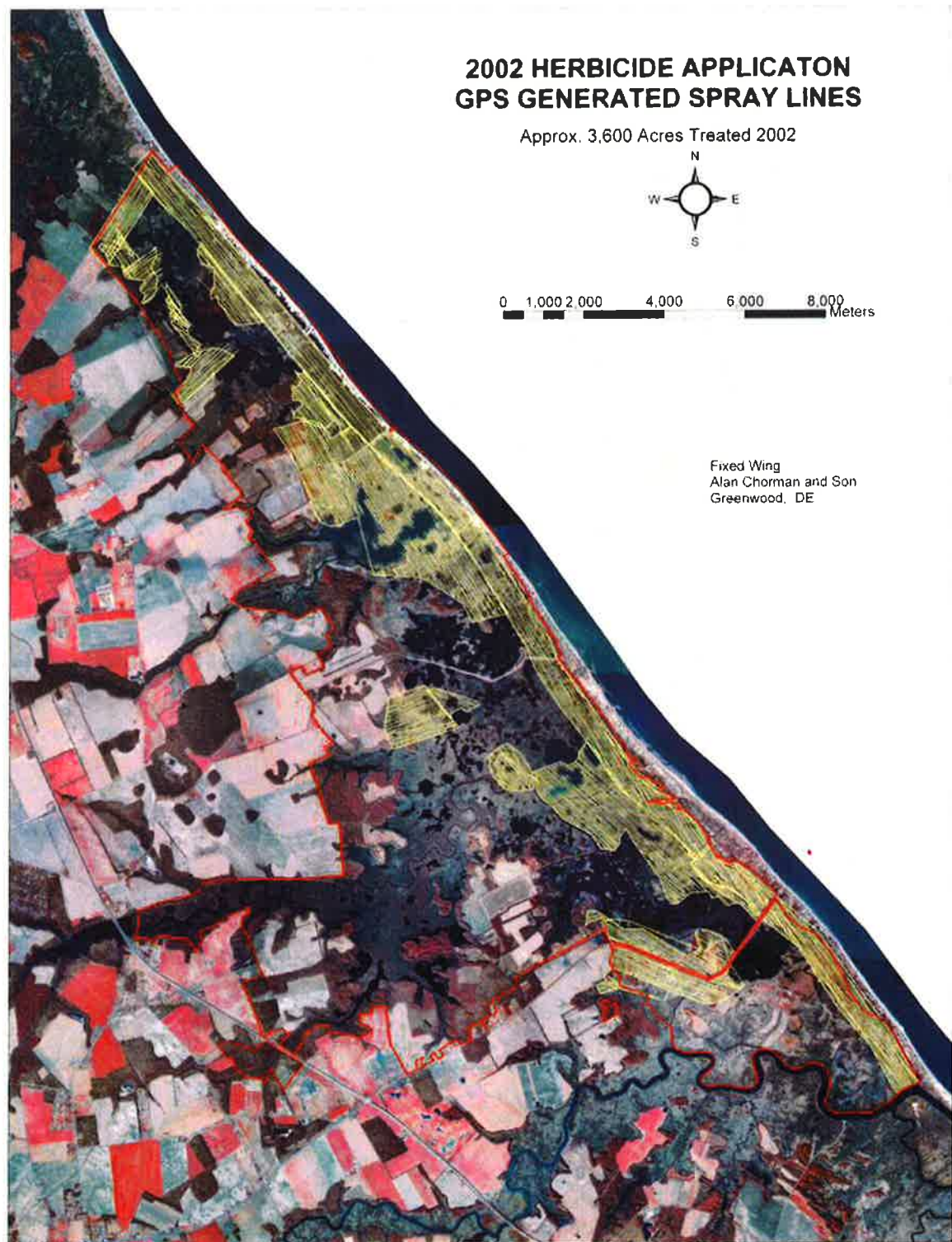


## Appendix C. Prime Hook WUI Project Map

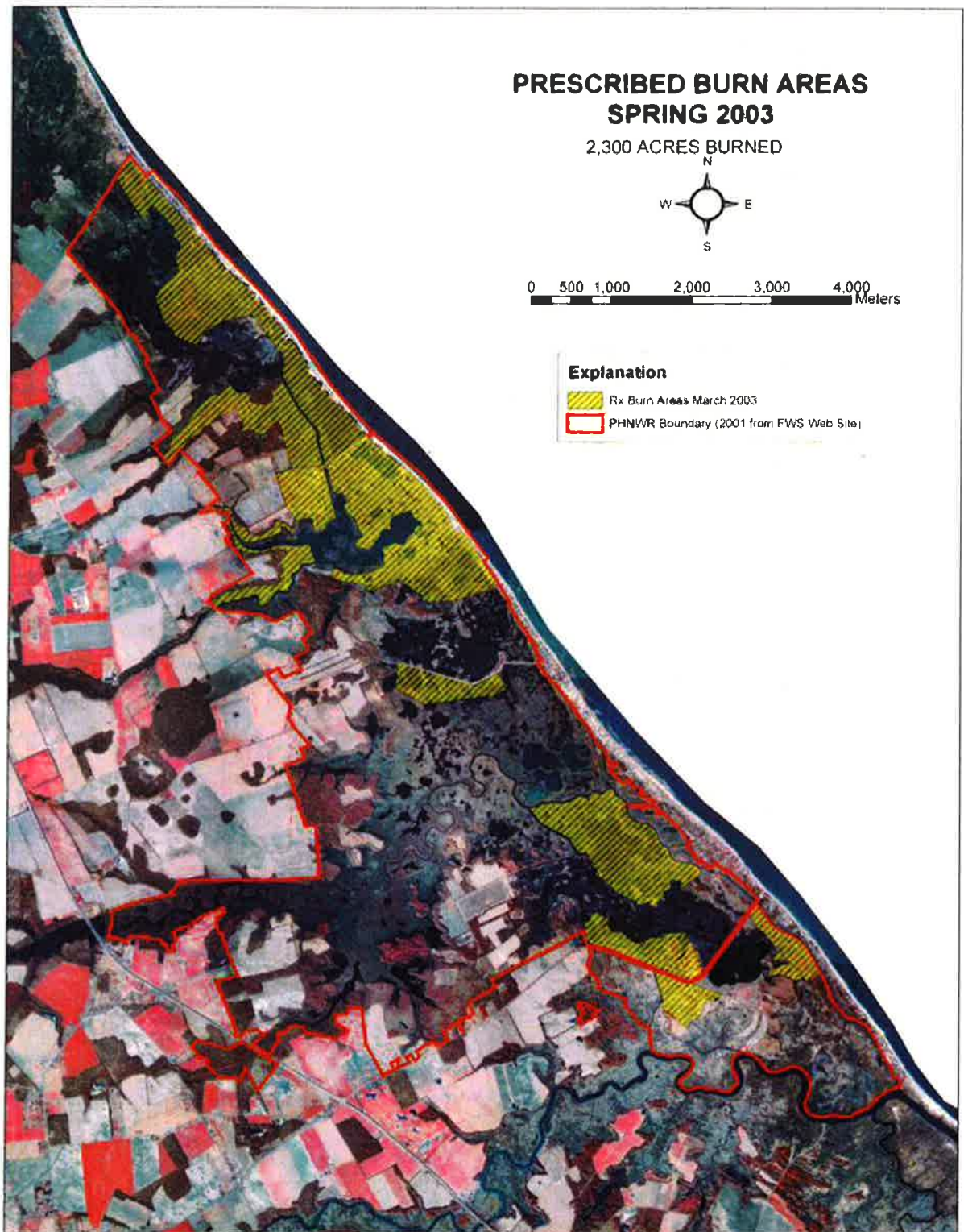
Note the locations of the Coastal Communities and Zero and Limited Tolerance Zones  
Slaughter Beach is at the left upper portion of the map.



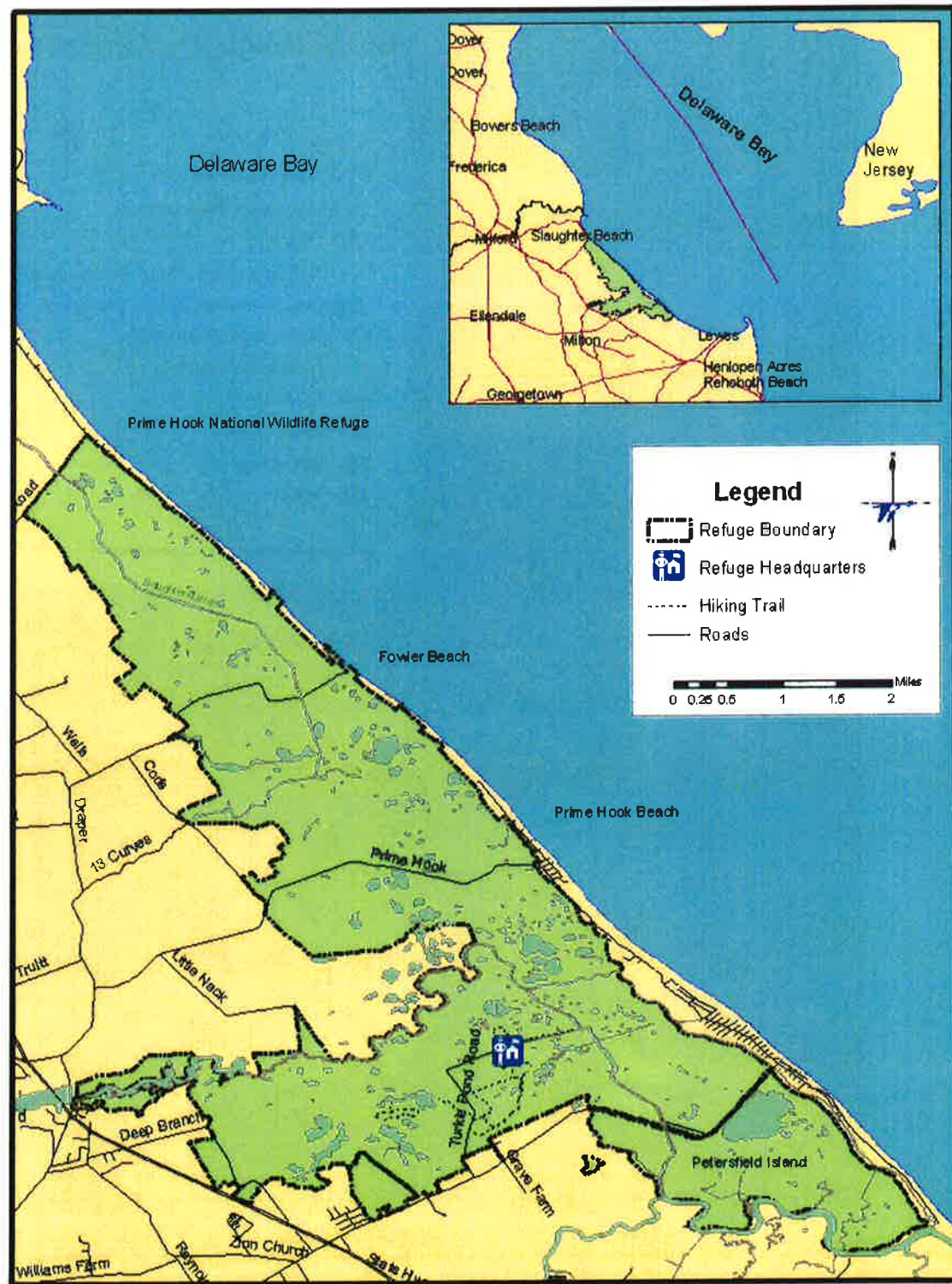
Appendix D. WUI Project Annual Treatment Maps





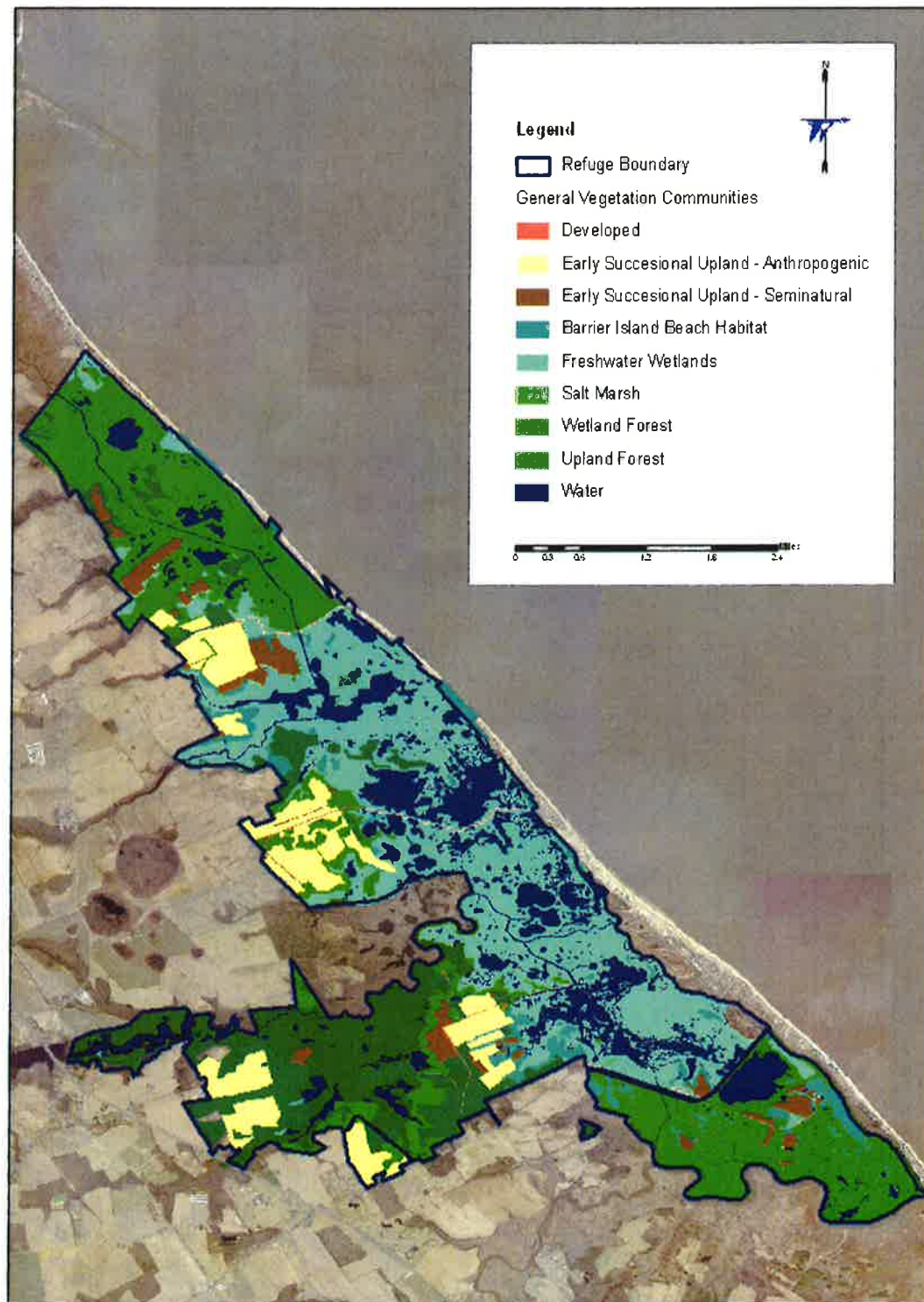


## Appendix E. Refuge Location Map, Habitat Map, and Monitoring Transect Map



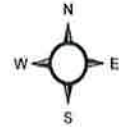


## Refuge Habitat types





## PHRAGMITES MONITORING TRANSECT LOCATIONS

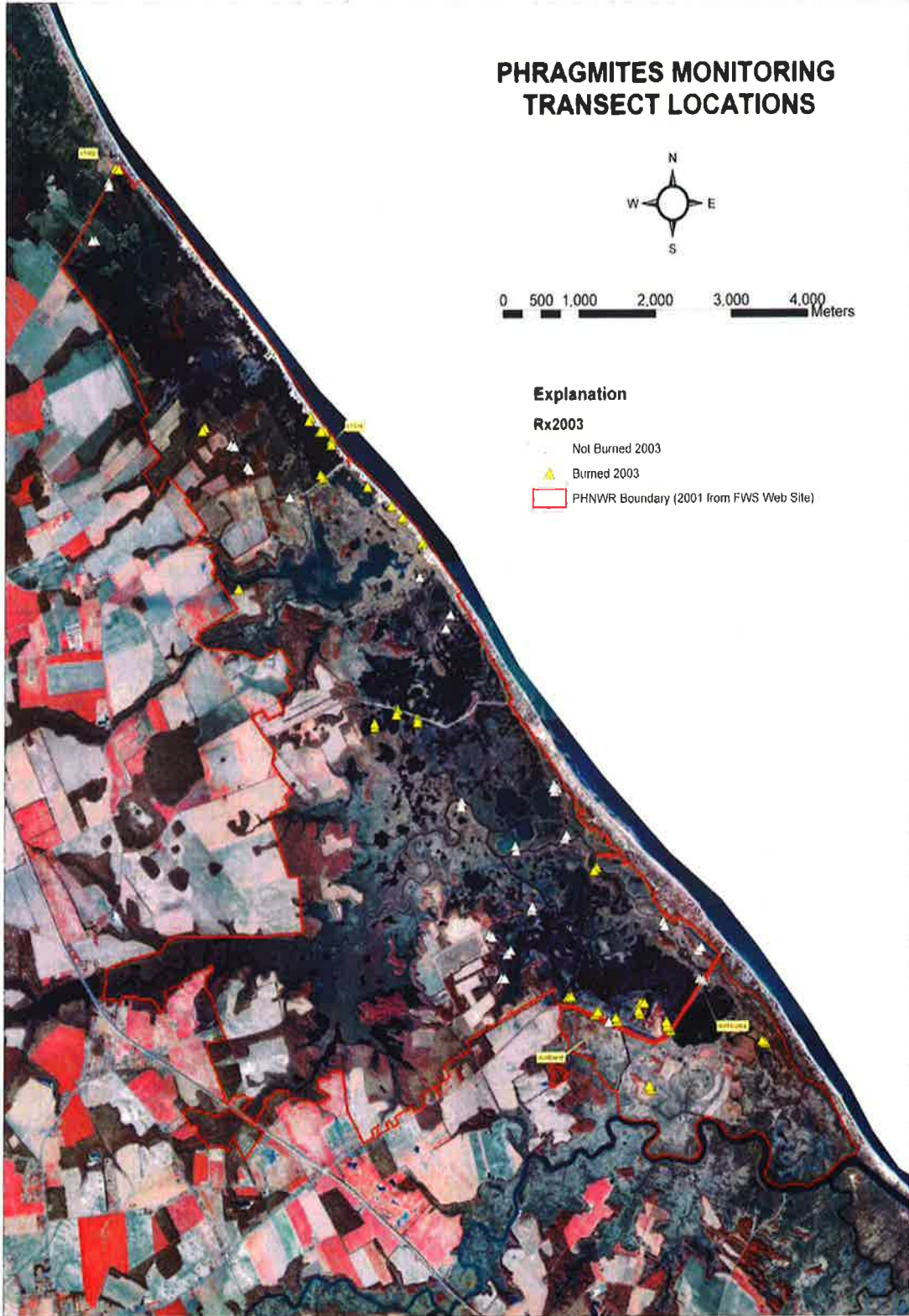


0 500 1,000 2,000 3,000 4,000 Meters

### Explanation

#### Rx2003

- Not Burned 2003
- Burned 2003
- PHNWR Boundary (2001 from FWS Web Site)



# WILDFIRE URBAN INTERFACE (WUI) MONITORING PROTOCOLS

## **FORM A: Vegetation Transect Photographs**

## **FORM B: Vegetation Sampling: Percent Frequency & Litter Depth**

## **FORM C: Vegetation Sampling: Dominant Species/Phragmites Density and Height**

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### **VEGETATION SAMPLING FIELD METHODS**

Random sampling locations will be located within defined GIS treatment polygons. Within designated areas of heavy Phragmites infestation, permanent vegetation sampling transects will be established and several measurements will be recorded for the next three years. These will include archival digital photographs for each transect (Form A), percent frequency and litter depth (Form B), and dominant species, Phragmites density {number of living Phrag stems/ square meter quadrat}, plus average and tallest Phragmites plant heights (Form C). Permanent vegetation plot studies are the most direct way to monitor changes. Permanent plots allow the application of statistical tests for detecting change and are more efficient to resample than temporary plots plus fewer numbers of plots are required to detect change or track trends. (Elzinga et al 1998)

Percent frequency measurements will be conducted using a point-intercept technique. This technique has a sound theoretical basis as the proportion of points intercepted equals the percent cover of that species. It is also considered to be the least biased and most objective method to obtain percent cover estimates. (Elzinga 1998) The point-intercept method uses a narrow diameter pole placed at systematic intervals along line transects to sample stand variation and quantify statistically valid changes in plant species cover and height over time. Percent frequency will be calculated as the number of “hits” for each vegetation category type divided by the total number of points per transect. A “hit” is defined as the pole touching a plant species or the ground cover class at each location.

Dominant plant species techniques will provide quantitative data on changes in plant species composition and relative abundance. Four 1-m<sup>2</sup> plots will be randomly located along each transect. Within each 1-m<sup>2</sup> plot the percent cover of each species present will be ranked by visual inspection using Daubenmire cover classes: (A: 0-5%), (B: 5-25%), (C: 25-50%), (D: 50-75%), (E: 75-95%), and (F: 95-100%). Ideally, using the same team of field observers each year will reduce any bias associated with the subjective assessment of vegetation cover.

### **Protocol A: Vegetation Sampling: Archival Photographs - Form A**

**Goal:** To visually characterize each transect.

**Personnel:** A team of two people will be required.

**Equipment:** A digital camera, Robel pole, and sight pole.

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**Steps:** Place Robel pole to anchor the 50 meter tape at the designated origin or start point for each random transect location. Place the sight pole 180<sup>0</sup> from the origin. Take a single photograph of the Robel pole from a height of one meter, alongside the sight pole (taking care not to include the sight pole in the photograph). This photo should be taken of undisturbed vegetation, so take the picture before taking any of the other vegetation measurements (Protocols B & C).

Use only a digital camera. Record the vegetation transect sample origin data, i.e., UTM coordinates, Northing and Easting of start point, compass bearing, transect number and date on Form A.

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### **Protocol B: Vegetation Sampling: Percent Frequency and Liter Depth**

**Goal:** Point-intercept method is used to determine the % frequency of plant species occurrences to assess changes in plant community composition over time. The method uses a narrow diameter pole placed at systematic intervals along line transects to sample within stand variation.

**Personnel:** A team of two.

**Equipment:** Field tape measurement (minimum 50 meter), a stake to anchor the far end of tape, a 4 mm diameter metal rod (about 2 m long), GPS unit, plastic ruler and white meter stick to measure litter.

**Percent Frequency:** Anchor the 50 meter end of field tape after navigating with the GPS to the origin of the transect line. Record the transect number (Refuge Management Unit I, II, III or IV, plus assigned number from the GIS sampling grid) Record both the start and end points (northings and eastings) for each transect. Fifty systematically spaced points along the transect will be sampled at one meter intervals. Place the metal rod directly adjacent to the field tape meter mark,

perpendicular to the ground. Determine all the vegetation types that touches the metal rod. Record the presence or absence of interceptions with a tick mark for each vegetation categories: Phrag less than 2.0 meters; Phrag greater than 2 meters; annual vegetation; perennial vegetation; dead vegetation, and water/bare ground.

A particular vegetation category is counted as intercepting the rod only once per point, no matter how many plants from that category intercept the rod, as this is a frequency measure and not dominance measure. Record all interceptions with tally marks on Data Form B. (A field list for common annual and perennial refuge plants, investigators will most likely encounter, will be included with data sheets)

**Sampling Litter Depth:** Litter depth measurements will be taken at 10 locations along the 50 meter transect. Measure the litter depth to the nearest cm at designated points. Work through litter layers either with the heel of your boot or trowel until the soil is located at the bottom of the profile. It is important not to disturb the profile by compacting it on successive scrapes. The profile that is exposed should then allow an accurate measurement of litter depth. Use a plastic ruler (or white meter stick) to measure the total depth of the litter profile to the nearest centimeter.

Where the rod touches the ground, note if the ground is totally bare (or water in wet marsh habitats) as opposed to being covered by litter. This should be a visual estimate made from above. Do not move vegetation aside to determine this. If the ground is bare, record a tally mark in the appropriate data column.

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**Protocol C:           Vegetation Sampling: Dominant Species, Phragmites  
Density and Height**

**Goal:** To determine the dominant plant species, identify the number of living Phragmites' stems (density), height of the tallest and average Phragmites plant/s at sampling points along the transect.

**Personnel:** A team of 2.

**Equipment:** 1- m<sup>2</sup> Frame, zip-lock bags (gallon) sized, and a table of random numbers (1 thru 50). Unique sets of 4 numbers per set ranging from 1 to 50 can easily be obtained from the Web Site, "Research Randomizer", ([www.randomizer.org](http://www.randomizer.org)) to select 4 quadrat locations per transect.

Prior to the start of vegetation sampling, mark two sides of the meter square frame at

distances of 0.224 m and 0.5 m mark along the side. These provide references for estimating the cut-off points of the cover scale ( 5%, 25%, 50%, 75%, and 100%).

At four random quadrats per transect place the meter square frame on the ground, over the vegetation. Use different random numbers for each transect. Place the frame parallel to and flush with the transect tape at the designated meter mark, on the opposite side of where you have been walking. Locate the frame to align with the random locations on the measuring tape.

Next measure the tallest Phrag plant, an average Phrag plant height and then count all of the live Phrag stems within the quadrat and record all data in the appropriate column on Data Form C. Then, in each quadrat, visually estimate cover per plant species, using the Daubenmire scale located on Form C. Note the total number of species of live, vascular plants in the quadrant. It is useful to record all plant species within the plot on the data sheet before estimating cover classes.

It is advisable to move vegetation aside to conduct this search. Next, make a visual estimate of the ranking of species by cover class. Beginning with the plant species with the greatest percent cover, identify the plant and estimate the its cover class (Daubenmire scale on Form C). All plants included within the dominance list should be identified to species. If there is a plant species that cannot be identified, store some individual plant samples in zip-lock bags and bring them back to the office with appropriately labeled bags.

[illegible][illegible]

**PRIME HOOK NWR-WUI MONITORING PROJECT -2004**  
**DATA FORM B - VEGETATION SAMPLING**  
**% FREQUENCY, LITTER DEPTH**

**Field Investigators:**

**Date:**

**Study Unit:**

**Transect Location in UTM: Zone = 18s - E:**

**N:**

<i>Transect</i>	<i>Phrag &lt; 2.0 M</i>	<i>Phrag &gt; 2.0 M</i>	<i>Annual Vegetation</i>	<i>Perennial Vegetation</i>	<i>Dead Vegetation</i>	<i>H2O/Bare Ground</i>	<i>25 -Litter Depth (cm)</i>
<i>Number</i> _____							_____
<i>Bearing</i> _____							_____
<i>0</i> _____							_____
<i>% Freq</i> _____							_____
<i>Number</i> _____							_____
<i>Bearing</i> _____							_____
<i>0</i> _____							_____
<i>% Freq</i> _____							_____
<i>Number</i> _____							_____
<i>Bearing</i> _____							_____
<i>0</i> _____							_____
<i>% Freq</i> _____							_____

**Data Form C: Vegetation Sampling**  
**Dominant Species/Phragmites Density and Height**

## Study Unit:

**N:**

**C: 25 - 50 %   D: 50 - 75 %   E: 75 - 95 %   F: 95 - 100 %**

Quadrat Location Along Transect (m)	Q1	Q2	Q3	Q4
Total number of Species per Quadrat				
Dominant Species	Cover Class Estimate (A - F)			
TALLEST PHRAGMITES HEIGHT				
AVERAGE PHRAGMITES HEIGHT				
Phrag Density per M <sup>2</sup> = Stem Count				
COMMENTS:				



**OVER-ALL BENEFITS OF PRESCRIBED FIRE AT  
PRIME HOOK NATIONAL WILDLIFE REFUGE:**

- ⇒ Reduce fuel loads in all habitat types to decrease fire intensity, to protect refuge and private property from severe fire events;
- ⇒ Increase habitat patchiness in marsh areas that provide wetland dependent species with a greater diversity of vegetation conditions from which to select optimal food and cover resources;
- ⇒ Enhance food and cover for DFS; augment mast production and open up forest under-story by light burning/low intensity surface fires.



Annabella Larsen, Wildlife Biologist  
Prime Hook National Wildlife Refuge 08/2000



**Burning Issues: Fire, Prescribed  
Fire and Prime Hook National  
Wildlife Refuge**

**Purpose of the Refuge:** Prime Hook NWR was established under the Migratory Bird Conservation Act (16 USC 715-715r) on August 21, 1962, for use as an inviolate sanctuary, or any other management purpose, expressly for migratory birds.

The refuge contains nearly 9,000 acres of which 75% consists of wetland habitats (4,500 acres of freshwater impoundments + 2,100 acres of salt marsh), 11% agricultural lands, 8% forested and the remaining 6% in scrub/shrub and grassland habitats. The refuge's main purpose is to conserve an important segment of the Delaware Bay marshes, to protect migrating and wintering waterfowl and shorebird habitats, and to assist in the orderly migration of these birds to and from their breeding/wintering grounds.

Prime Hook's operational objectives include the following: 1.) Provide resting habitat and food resources for migratory birds, especially migrating and wintering waterfowl and migrating/breeding shorebirds; 2.) Provide habitat for the endangered Delmarva Fox Squirrel (DFS);



Anaesthetizing a Delmarva Fox Squirrel prior to Health Screening and Obtaining Vital Statistics



3.) Provide nesting and wintering habitat for T/E species like bald eagles and peregrines; 4.) Provide nesting and resting wetland habitats for Wood Ducks and Black Ducks, and manage forested and grassland areas for neotropical land birds and resident wildlife; and 5.) Provide hunting, fishing, wildlife observation and photography, environmental education and interpretation opportunities for refuge visitors.

**Refuge Fire History and Use:** A critical component of the habitat management endeavors at Prime Hook NWR is the re-establishing and maintenance of early successional vegetation within its marsh, grassland and forested habitats. The key management tools used to alter ecological succession include water control, herbicide use to control *Phragmites* and fire. Fire is also a crucial ecological process used in woodland habitat manipulations. Fire use involves the creation of diverse plant communities that emphasize species richness and biodiversity which helps target the recovery and management of the endangered DFS. Fire is also essential in reducing unsafe fuel accumulations of dead *Phragmites* canes.



Typical Low Intensity Surface Fire

Fire has been both a natural and applied phenomenon, which has played a role in ecosystem dynamics of the natural communities represented within the refuge's diverse mosaic of habitat types. Historically, fire was used in refuge marshes as "cover-burns" by trappers to facilitate the capture of muskrats before the refuge was established. Likewise, farmers burned switchgrass (*Panicum virgatum*) and saltmeadow grass (*Spartina patens*) to maintain these habitats in a healthy and highly productive state of pasturage. During the 1970s to the mid 1980s, prescribed fire was regularly used to reduce hazardous accumulations of *Phragmites* and woody fuels. This was applied to both marsh and certain pine-oak forested areas (DFS habitat enrichment), with a frequency of 2-5 years. This maintained vigorous and diverse upland and wetland plant communities in various stages of post-fire succession, providing a wide variety of habitat niches and conditions that benefit wildlife.



Prescribed Burn, Unit IV, 1986



Unit IV after burn, Jan. 1987  
Note large open ponds with increased water levels.

Human carelessness and arson have resulted in larger fires occurring on the refuge, most notably:

**1969:** Arson start burned 1500 acres of wetland habitat in Unit II and III, which endangered two beachfront communities (Prime Hook and Broadkill)

**1977:** A fire of undetermined origin burned 1000 acres in Unit II, 95% of which was fueled by *Phragmites*. The primary cause of concern in suppressing the fire was saving the houses abutting the refuge marsh along Prime Hook Beach. (Note: these beach communities have grown substantially since 1977.)



Wildfire, 1977. Over 200 volunteers from eight fire departments, the Lewes Naval Facility, Delaware Forest Services and Delaware State Police battled this blaze for 3 days.

**1986:** Unit I, 500 acres of salt marsh habitat near the Slaughter Beach Community.



## SNOW GEESE AND FIRE - SIMILARITIES????



Fire has much in common with herbivory, especially vertebrate grazing, like snow goose "Eat-Outs", which have been extensive in the last decade on refuge. Fire, as a major generalist consumer of plant biomass, is positively viewed, very similarly to snow goose browsing. When used in wetland habitats, prescribed fire can be an important agent in structuring wetland vegetative communities with greater productivity and diversity. New openings created, provide the potential for maximizing vegetation change. Fire can also expedite detrital processing of coarse organic matter of dead standing crops into finer organic particles, thus benefiting macroinvertebrate production the following growing season.

Thus, fire, as a major consumer of plant biomass can play pivotal roles in wetland food chain dynamics by accelerating the detrital processes and enhancing the seed production of desirable annual vegetation and associated invertebrate food resources.

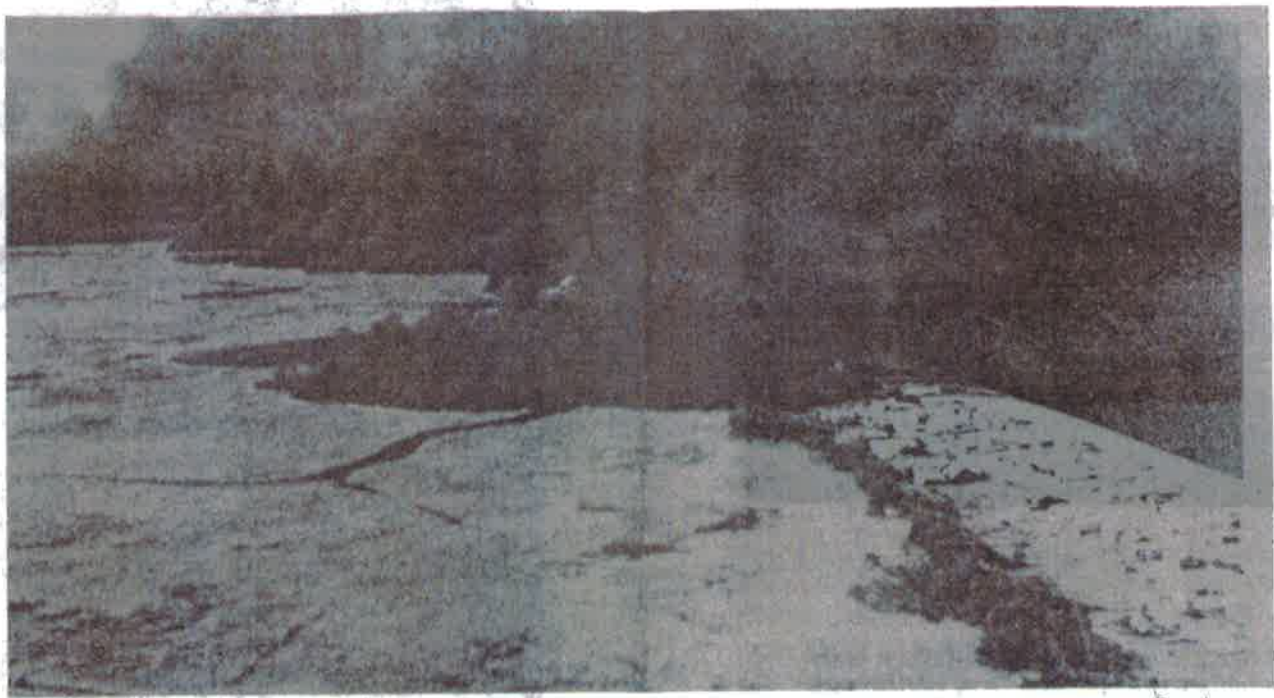
On the other hand, the exclusion of fire has often resulted in serious misjudgments in the conservation or management of fire-prone ecosystems. It is still widely perceived as an agent that destroys the 'balance of nature' rather than a process that helps preserve, enhance and protect biodiversity.

NOTES ON THE FIRE ECOLOGY AND FIRE EFFECTS OF PHRAGMITES: Phragmites offers little cover and no food value for migrating or wintering waterfowl, and it out-competes more desirable annual moist-soil vegetation. Because of its manifold undesirable qualities, it is often necessary to control it in marshes that are managed for waterfowl and shorebirds.

Fire Ecology. Fire adaptations of this incredible plant precludes the use of fire to control it. Herbicide treatments are the most effective. Phragmites' rhizomes are deeply buried in the soil so heat from fire does not penetrate deep enough into the soil to injure the plant's regenerative powers. When fire consumes the above-ground foliage, new top-growth is initiated from the surviving root system.

Fire Effects. Phragmites' stands are typically very dense and contain much cumulative dead material. Standing dead canes and litter often constitute twice as much biomass as living shoots. This abundant dead fuel carries fire well, allowing stands to burn even when the current year's shoots are green. This can be a particular nightmare at the Urban/Marsh interface where sprayed Phragmites stands, adjacent to beach houses, still pose a very considerable fire hazard. In predicting the fire behavior of Phragmites, Fuel Model # 3 is used to estimate the rate of spread, in conjunction with Fuel Model #4 (Shrub-Chaparral Group), which is used to estimate flame length and fire intensity.

Fuel management of Phragmites entails the use of herbicide, prescribed fire, mowing and/or mashing fire breaks to alter fire effects. This is especially important near beach communities and to reduce costs of fire suppression. However, any type of burn or fire application will always favor Phragmites. Fires do remove the standing dead canes and accumulated litter, but also allow the soil to warm up rapidly in the spring and fall, which can result in heavier stand growth the following growing season. Planning prescribed fire in conjunction with herbicide applications or heavy Snow Goose grazing are novel ways to curb Phragmites expansion. For example, plants burned during the late summer or early fall usually initiate new top-growth within a few days. Stem density is greatly reduced, but tender new shoots offer seductive foraging tidbits to hungry hordes of Snow Geese arriving from the Arctic breeding grounds.



Aerial News Photo, from The Whale, April 20, 1977, Showing the extent of the blaze at the North end of Prime Hook Beach.

BY JIM CRESSON

**PRIME HOOK REFUGE**—On a dry windy Wednesday that generated 16 separate fires and 80 fire alarms in Sussex County, the biggest blaze consumed about 1,000 acres of federal marshland at Prime Hook Wildlife Refuge and threatened to burn Slaughter Beach before firefighters turned the blaze and saved resort homes.

Of Sussex County's 21 volunteer fire companies, 19 responded to alarms. Wednesday, activating nearly 300 mobile units and more than 500 firefighters, county emergency planning director Wayne D. Ellingsworth said Thursday morning.

"It was a tough day, but those volunteer firefighters did a remarkable job of protecting property," Ellingsworth said. Unusually dry conditions and erratic gusty winds caused the brush and woods fires to spread rapidly, he explained.

Coastal area fires erupted in Oak Orchard and near Millsboro, Ellingsworth said, but the blaze at Prime Hook was the one which spread the fastest and endangered the most property.

Slaughter Beach Fire Chief Alan Jester said his company was first called at noon about a marsh fire in the Fowler Beach area, just south of Slaughter Beach. Fowler Beach is an undeveloped fishing area at the end of County Rd. 221, surrounded by federal refuge land.

"We couldn't get out on the marsh to fight the fire. We hoped it would burn itself out, but it didn't; the winds fanned the flames northward and soon the whole marsh was on fire and Slaughter Beach was right in its path," Jester said.

Capt. Greg Beideman put out a call for assistance. It was answered by nine companies and 150 firefighters from as far away as Dover to the north and Blades to the south.

"We were really hard pressed to turn the blaze," Beideman related after the fire. "There was a wall of flame coming right at the homes on the south end of the beach, and we had to turn it, or else."

While firefighters did manage to turn the blaze back onto the marsh and away from beachfront homes, sparks ignited several lawns. The two-story summer home of Vincent J. Esposito was the only home to receive fire damage, as the roof and attic burned before Beideman and his crew broke into the house and extinguished the flame.

Once the fire had been turned, and a backfire had been set along the inland border of the marsh, firefighters stood by and let the blaze burn itself out. At dusk, only a few isolated fires still burned, and the bulk of the marsh, previously covered with dry phragmites weed, was reduced to blackened stubble.

Prime Hook Wildlife Refuge manager George O'Shea said Wednesday night that the phragmites weed is a nuisance plant, drawing water from the marsh, choking out other more desirable plant life and always threatening to fuel runaway

Currently, prescribed fire is sorely needed to reduce the very high fuel concentrations of Phragmites' stands and to reduce the considerable fuel-loading in certain forested areas that sustained extensive ice-storm damage in 1994. Reducing the severe wildfire hazard is paramount.

Heavy Phragmites fuel-loading from tons of dead cane also washed into Unit II from the severe Nor'easter flooding in 1998. This has compounded the Phragmites fire hazard problem. Loss of grassland acreage due to encroaching shrubs and trees, plus several shrubland areas have also reverted to impenetrable thickets. The last prescribed burn was performed in 1988.

#### **Ecological Importance of Fire at Prime Hook**

**NWR:** The integration of managing for natural biological diversity and ecological integrity is greatly enriched by explicitly including fire in habitat conservation practices and equating fire to related ecosystem processes, such as vertebrate grazing. This is particularly true when attempting to increase the carrying capacity of any habitat type with intensive management practices. For example, the importance of fire as a 'disturbance agent', in the dynamics of plant and animal interaction, is recognized as an important mechanism for maintaining and enhancing food resources of the marsh ecosystem.

News paper article from the Coast Press, March 27, 1986

The article describes some of the difficulties the fire fighters encounter with Phragmites marsh fires.